GOVERNMENT OF INDIA

MINISTRY OF EDUCATION

REPORT OF THE SCIENTIFIC MAN-POWER COMMITTEE (SURVEY AND ASSESSMENT)

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SECTION I—INDUSTRIES

A. Chemical Industries

1. Industries concerned with the production of Heavy Chemicals (Mineral acids, alkali chlorine, inorganic salts, soda ash, etc.), fertilisers, fine chemicals, drugs and pharmaceuticals, soaps, oils and fats, paints and varnishes and essential oils, *i.e.*, mainly with chemical processing are dealt with in this sub-section. Chemists of various categories and to some extent, engineers are required in these industries.

2. While most of the above products are produced in India, the industries producing these are not evenly distributed throughout the country owing to the varying local conditions, especially in the matter of availability of raw materials, power, labour (both skilled and unskilled), transport facilities etc. In certain areas the State aid, which has been extended, has contributed largely to the develop ment of the industries.

Heavy Chemicals

3. Great strides have been made in India in a number of industries such as iron and steel, textiles, sugar, cement and jute during the last war but the advance in chemical industry has not been commensurate with the potentiality in the country notwithstanding the fact that several large heavy chemical concerns have been established very recently.

4. The term 'Heavy Chemicals' is generally understood to refer to those chemicals that serve as raw materials or as treating agents for other processing industries, such as textiles, soap, rayon, fertilisers, glass, leather, paper, etc., which are their principal consumers. The heavy chemicals are sulphuric acid and other mineral acids and related compounds, soda ash, caustic soda and fertilisers. But in recent times, a large number of new chemical products of industrial importance have also been included under this group as given below:

(*a*) Sulphur and its compounds—Sulphuric acid, ammonium sulphate and alum, magnesium sulphate, iron sulphate, copper sulphate, sodium sulphate, sodium sulphide, sodium sulphite, sodium thio-sulphite, sodium hydrosulphite.

(*b*) Alkali products—Common salt, lime, soda ash, sodium bicarbonate, sodium silicate, calcium cyanide, caustic soda, chlorine and potassium chlorate.

(*c*) Cholorine products—Hydrochloric acid, chlorides of zinc, mangnesium, potassium, barium, iron etc.

(*d*) Nitric acid and nitrates.

(*e*) Ammonia and ammonium chloride, carbonate and bicarbonate.

(*f*) Fertilisers—Ammonium sulphate, urea, ammonium nitrate, potassium nitrate, cynamide, phosphate of potassium.

(*g*) Calcium carbide, sodium & potassium dichromates, chromic acid and other inorganic chemicals.

(*h*) Organic compounds—Methyl alcohol, acetone, acetic acid, acetylene, glycerine, formaldehyde starch, glucose.

Industrial gases—Oxygen, hydrogen, carbon dioxide, acetylene.

(*j*) Coal tar products—Phenol, cresols, naphthalene, benzene, etc.

Present Position

5. Questionnaires were issued to all the principal chemical concerns in the country and replies have been received from some concerns. An analytical summary of the completed questionnaires is given in. In this will be seen for each concern the principal lines of manufacture, quantity and value of production,

the total labour and scientific and technical staff employed, research facilities and specialised equipment available, particulars of development and expansion projects, as also the views of the concerns on the adequacy or otherwise of the basic training received by new recruits to scientific and technical posts in the industry, co-operative research, procurement of equipment, training abroad, training facilities available and other matters.

The following table shows zone-wise the production figures of principal heavy chemical products of such of the concerns as have supplied information or about which informtion is available.

PRODUCT	Annual production in tons. (Figures in brackets indicate the no. of concerns manufacturing)			
	Southern Zone	Western Zone	Northern Zone	Eastern Zone
Ammonia	13,080 (2)			
Sulphuric acid	35,600 (3)	12,100 (6)	13,500 (10)	39,500 (7)
Ammonium sulphate	48,000 (3)			
Inorganic salts	3,100 (3)	6,000 (1)	10,520 (3)	2,540 (2)
Sodium silicate	100 (1)	100 (1)		
Chromates dichromates and chrome pigments	1,470 (1)	1,750 (4)	1,200 (1)	460 (4)
Other mineral acids	600 (3)		1,310 (3)	
Caustic Soda	1,500 (1)			
Soda ash		54,000 (2)		
Bleaching powder	2,400 (1)			
Liquid chlorine	250 (1)			
Superphosphates	7,100 (2)		3,810 (1)	
Mixed fertilisers	20,000 (1)			
Miscellaneous Marine salts and other chemicals		1,600 (1)		
Common salt		185,000 (2)		
Coal tar products:				
Phenol				25 (5)
Cresylic cid				60 (5)
Napthalene				600 (5)
Heavy cresote oil				500,000 gallons (5)

6. It is to be noted that the above table includes the production capacity of new units, which have been recently installed and which have either gone into production or are in the course of it. In some cases and especially in the case of soda ash, the production capacity has been stated but the actual production due to various reasons is very much less. It has not been possible to obtain a correct estimate of the monetary value of the products.

Southern Zone

7. From the above table, it will be seen that the Heavy Chemical Industry for the production of ammonia and sulphuric acid in the Southern Zone has developed considerably. These products are primarily used for the manufacture of ammonium sulphate for use as fertilisers. The alkali-chlorine industry, however, has not developed to any appreciable extent. Only one firm is manufacturing caustic soda and that too, about 1,500 tons per year which is less than 8 per cent. of the present requirements of the zone. The only firm producing chlorine as a by-product of the alkali industry by electrolytic process consumes the bulk of its production for the manufacture of bleaching powder. A certain amount of chlorine is also liquified and sold. There is only one concern engaged in the manufacture of chromates and dichromates, chrome pigments and other specialised inorganic chemicals. Coal tar products are not manufactured in the Southern Zone due to absence of coal and coal carbonization industries. Oxygen, hydrogen and carbon-dioxide are being produced in considerable quantities as by-products with the exception of hydrogen Hydrogen required in the Haber process of ammonia synthesis is being produced both by electrolytic and thermal iron-oxide process. It is to be noted that no calcium carbide is being

produced in this zone. The manufacture of ammonia, sulphuric acid and ammonium sulphate is generally carried out in one single unit, the first two being used for the manufacture of the third in each of the two large plants—one at Mysore and the other at Travancore. It is to be noted that both the direct neutralisation process and the anhydrite or gypsum process are employed for the manufacture of ammonium sulphate. The Travancore plant incorporates a series of the latest chemical engineering developments.

8. Barring only one concern which employs the Chamber Process, the bulk of sulphuric acid is produced by the standard vanadium contact process and the plants in operation are, therefore mostly modern ones. Superphosphates are produced by almost all the factories producing sulphuric aid and by using principally bone meal. Definite plans are, however, underway—at least in one concern for employing phosphatic minerals either available locally or imported from America.

The manufacture of caustic soda, liquid chlorine and bleaching powder has been taken up by only one concern as one single unit and primarily with a view to producing one final product *viz.*, bleaching powder. Caustic soda which is produced electrolytically is partly consumed for the manufacture of soaps etc., and the rest is released for consumption outside. Other mineral acids like hydrochloric acid and nitric acid are being produced particularly by factories producing sulphuric acid by treating sulphuric acid with sodium chloride and nitrates respectively: but one concern produces hydrochloric acid by direct synthesis from hydrogen and chlorine.

9. While discussing the Heavy Chemical Industry in the Southern Zone, special mention must be made of the Cordite Factory at Aravankadu which is one of the important defence establishments of the Government of India. This factory is mainly intended for the production of propellant explosives (cordite) for the use of the Indian Army. The manufacture of cordite entails the use of a large number of auxiliary chemicals such as sulphuric acid, nitric acid, nitro-cellulose, nitroglycerine, acetone, etc. all of which are being produced at the Cordite Factory. The following indicates the production capacity of the factory for the various products :

Sulphuric acid	2500 tons/year
Nitric acid	2500 ,, ,,
Nitroglycerine	750 ,, ,,
Acetone	1000 ,, ,,
Nitro-cellulose	750 ,, ,,
Cordite	3000 ,, ,,

The most important feature of the factory is that nitric acid is produced by the modern catalytic oxidation process, namely oxidation of ammonia into nitric acid, and the plant in operation at the factory is one of the only two of its kind in the country, the other being in operation at the High Explosives Factory at Kirkee. Acetone is manufactured by the oxidation of alcohol and the Cordite Factory has the only plant available in the country for that purpose. The Cordite Factory is also the only place where nitro-cellulose and nitro-glycerine are being manufactured.

The value of the plant and machinery in the factory is about Rs. 1 crore and the total technical staff employed is 94 consisting of chemists and engineers. The normal peace-time requirement for cordite in India is about 200 tons/year and the factory produces about the same quantity at present. This production represents only about 16% of the total capacity of the factory working one 8 hours shift per day or 6% working all the three shifts; and consequently, only 3% of the machinery installed is being utilised. It will be of some importance to mention here that during peace-time, the Cordite Factory can produce goods for civilian purposes. Sulphuric and nitric acids are important mineral acids for which there is always a demand in the country. As an important solvent in Paints, Varnish & Lacquer Industry, acetone is also in considerable demand and we have referred to this aspect in the section on 'Paints & Varnishes'. Nitro-cellulose is an important lacquer and the Cordite Factory, the only place in the country where this product is produced can meet the civilian requirement for it. Besides, the factory can also produce various civilian explosives such as Fitted shot gun cartridges, rifle and other cases, blasting fuses, blasting gelatine, gelatine dynamite (gelagnite), nitro-compound explosives for civilian purposes, deternators etc. The bulk of these civilian explosives and ammunition is being imported at present and in

1945-46 such imports cost about Rs. 5 million. From these considerations, it may be inferred that a positive and conscious effort should be made to utilise to the best advantage the men and material available in the various defence establishments in the country, especially in the Cordite Factory and the High Explosive Factory for the production of goods of civilian importance when such establishments are not engaged in producing war materials.

Western Zone

10. Heavy Chemical Industry has also developed in the Western Zone on a considerable scale due to the large scale manufacture of soda ash, caustic soda, chemicals from sea water, chromates and dichromates and magnesium products. Large-scale manufacture of soda ash at Mithapur and Dharangadhra, in this zone is worthy of note. The production capacity is stated to be 54,000 tons of soda ash/year, but in recent times, the actual production has fallen down considerably, due to various reasons. This zone also produces about 185,000 tons of salt for chemical and other industries. Recovery of bromine and other valuable chemicals from sea weeds is an interesting feature of the chemical industry in the Western Zone.

We have not been able to obtain complete information regarding the production of various products in this zone consequently col. 3 of the table has many a gap.

Northern Zone

11. The manufacture of sulphuric and other mineral acids is a special feature of the Heavy Chemical Industry in the Northern Zone. The sulphuric acid produced is utilized in the factories partly for the manufacture of inorganic sulphates, especially of alums. There are 12 principal concerns. Superphosphates are being produced by one concern, presumably using bone meal. It is to be noted that little or no ammonium sulphate is being produced in this zone and neither alkali-chlorine industry nor soda ash industry has developed. We have not been able to obtain the production figures for the various products from all the concerns in the zone. Consequently col. 4 of the above table represents the production of a few concerns only.

Eastern Zone

12. Heavy Chemical Industry, especially for the manufacture of acids and inorganic salts has developed on a considerable scale in the Eastern Zone, which is also shortly to have under production the largest fertiliser factory in the country, capable of producing about 1,000 tons of ammonium sulphate per day. In due course this factory will also produce various other heavy chemicals such as urea, formaldehyde, sulphuric acid from gypsum etc. The most important feature of the Heavy Chemical Industry in this zone, however, is coal carbonisation and coal-tar distillation. There are 8 tar-producing plants with an installed capacity of about 85,000 tons per year; and 5 distillation plants capable of distilling 60,000 tons of tar/year. But the actual quantity of tar distilled at present is stated to be much less—being only about 36,000 tons. The Panel on Heavy Chemical Industries estimates that the total annual output of benzol is 2·4 million gallons from which 1·2 million gallons of pure benzene could be recovered. In column 2 of Table I is shown the prduction of various coal-tar distillation products in the Eastern Zone.

Technical Personnel employed

13. The technical personnel employed in the Heavy Chemical Industry in the country consists distinctly of two categories, *viz.,* chemists and engineers, but only very few of the engineering personnel employed, it appears, have had orthodox training in chemical engineering. As regards chemists, it may be presumed that graduates and post-graduates in chemistry are taken into the factory and trained in the various processes, operation and control as well as routine work. Similarly engineering graduates and diploma holder are trained in the chemical engineering aspects of the industry. Our information in respect of the technical personnel employed in each individual concern in all the zones, excepting the Southern Zone is incomplete.

Besides the production capacity of the plants for any main group of products varies between very wide limits and some concerns produce side-lines which do not belong to the category of 'Heavy Chemicals', although these are chemical products and entail the use of acids, alkalis etc., as the raw materials. However, on the basis of the available data, relating to cetain representative and principal ones we infer that the heavy chemical industry as it exists in the country, today employs about four chemists and two engineers for the production of 1,000 tons of heavy chemicals per year.

In arriving at the above figures, we have taken into consideration only the quantity of production of the end-products. For instance in a Fertiliser Factory producing ammonia, sulphuric acid and ammonium sulphate, we have taken into consideration the production of ammonium sulphate only.

Development and Expansion

14. The trends of development of Heavy Chemical Industry in the various zones during the next 5-year period appear to be well defined in two definite directions :

(*a*) Increase in the production of such of the chemicals as are now being produced ; and

(*b*) The manufacture of new products.

15. In the Southern Zone, definite projects are underway for increasing the production of ammonium sulphate by 50,000 tons per year and superphosphates by 53,000 tons per year. The production of other mineral acids will increase by 5,500 tons per year. It is proposed to manufacture both rayon and ordinary grade caustic soda, the total additional production aimed at being 31,500 tons per year. One firm is contemplating to manufacture high test bleach or hypothon at the rate of 15 tons per day. 4 new plants of a production capacity of about 130,000 tons of soda ash per year has been planned. Consistent with increase in the production of sulphuric acid and other mineral acids, the manufacture of inorganic salts will also increase correspondingly. Of the important new products proposed to be manufactured, special mention must be made of DDT, urea and titania pigments. The contemplated production of these compounds are 3,000, 9,000 and 1,500 tons respectively per year. Certain proposals are also under consideration for the utilization of by-product chlorine for use, especially in the manufacture of polyvinyl chloride and chlorinated rubber products.

16. In the Western Zone, plans are underway for the establishment of two sulphuric acid factories, one in Bombay and the other in C.P.each with an annual production capacity of 6,000 tons; and of a soda ash plant in C.P. with a production capacity of about 50,000 tons per year. The existing concerns have contemplated not only an increase in the production but also the manufacture of new products which are not at present being manufactured.

17. Increase in the production of sulphuric acid, superphosphate, bone products and inorganic salts has been envisaged in the development plants of the concerns in the Northern Zone.

18. Of the most important developments in the Heavy Chemical Industry in the Eastern Zone is an increase in the production of sulphuric acid by 12,300 tons per year; inorganic salts by 6,780 tons per year, superphosphates by 13,000 tons and caustic soda by 3,400 tons per year. A large fertiliser factory for the manufacture of ammonium sulphate at the rate of 1,000 tons per day is being established by the Government of India at Sindri in Bihar.

19. The above relate only to projects which are underway or have been planned and do not complete the picture of development of Heavy Chemical Industry. The growth of the Heavy Chemical Industry is largely influenced by the development of consumer industries such as for instance, fertilisers, soaps, glass, paper, ceramics, textiles, plastics, pharmaceuticals & drugs, rayon, paints, etc. We shall refer to some of these consumer industries at a later stage in detail. Here we should mention that few of these industries have reached anywhere a state of self sufficiency. There are still very wide gaps in the general agricultureal and industrial economy of the country which can only be bridged by planned utilization of the available natural resources. Towards this, Heavy Chemical Industry will play a very important role. For example, for the scientific development of agriculture chemical fertilisers should be used especially in a soil like the one obtaining in many parts of the country which has been impoverished by continuous farming for ages. A conservative estimate of the immediate requirements of nitrogenous and phosphatic fertilisers for the improvement of the land under cultivation in the Southern Zone alone has been estimated at 200,000 tons of ammonium sulphate and 100,000 tons of superphosphates per year.

Computed against the present and planned production of these chemical fertilisers in this zone, there is still a balance of 100,000 tons of ammonium sulphate and 50,000 tons of superphosphate which will have to be met by establishing more fertiliser factories. For the whole country the additional requirements of fertilisers will be atleast 4 times more. For the new lands that are now being brought under cultivation, another 500,000 tons of ammonium sulphate and 250,000 tons of phosphatic fertilisers would eventually be required.

20. The Government of India set up, in 1945 a Panel on Heavy Chemical Industry to advise the Government on the scope and extent of development of Heavy Chemical Industry in the country during the next 5 or 10 year periods keeping in view the requirements for the various products. The targets of production for the various heavy chemicals suggested by the Panel are given in column 3 of Table II. Considering the growing need for the various products and the resources available for the production of these, we believe that the targets fixed by the Panel are capable of attainment, and also represent the development of the industry as it ought to take place. Indeed, many of the development projects, which we have examined relating to the heavy chemical concerns in the country follow closely in many respects the recommendations of the Panel.

Elecrto-chemical Industry

21. Special mention must be made here of the importance of Electro-chemical Industry in the country. Except for 4 or 5 concerns which use electricity on a low scale for chemical operations (for the manufacture of caustic soda, for the generation of hydrogen for ammonia synthesis and for the manufacture of aluminium), electro-chemical industry is practically non-existent. The combined generation capacity of hydro-electric installations in the Southern Zone alone is of the order of about 300,000 K.W. at present, and during 1944, 2054 million K.W. of hydro-electricity were generated in the whole of the country. The latter represents about 55% of the total electrical energy generated both by thermal and hydro-plants. Several large hydro-electric projects for harnessing the water power resources of the Southern Zone are underway and, as a result, the generating capacity will increase by another 350,000 K. W. during the next 5—10 year periods. Similar hydro-electric projects have been proposed or are underway in other zones. All this energy which, it is hoped, will be available at a cheap rate is bound to play a great role in the industrial economy of the country and will give a tremendous impetus to the development of numerous industries, especially electro-chemical and electro-metallurgical industries. From a study of the raw material resources of the country it seems there are great possibilities for the manufacture of the following chemicals and electro-metals :—

Alkali chlorine, calcium carbide, phosphoric acid, calcium cynamide, hydrogen peroxide, carbon-di-sulphide, organic chemicals, artificial abrasives, artificial graphite, steel, ferro-alloys, aluminium, magnesium sodium, etc,

22. Alkali Chlorine manufacture has already been dealt with in para. 15 above. For the development of pharmaceutical and dyestuff industries in the Southern Zone, manufacture of calcium carbide is of special importance. The present requirement of calcium carbide for the whole of India is about 7,000 tons of which, 5,000 tons are proposed to be met by a factory to be set up in Bihar. The balance of 2,000 tons, the Electro-chemical Panel have recommended, should be produced in Mysore. Since the present demand of calcium carbide is mostly for the generation of acetylene for oxy-acetylene welding,the recommendtion of the Panel is limited to the extent of meeting this demand and does not envisage possibi lities of development of pharmaceutical and dyestuff industries depending on calcium carbide. In the absence of reliable data, it is hard to assess the requirements of calcium carbide for producing the variows chemical intermediaries and raw materials for the consumer industries. But it may be assumed that, in addition to the 2,500 tons of calcium carbide recommended by the Panel to meet the present demands, another 25,000 to 30,000 tons of calcium carbide will be required, in due course of time.

23. Carbon-di-sulphide is an important chemical required in the manufacture of rayon by the viscose process. For each ton of rayon, about 0·45 ton of carbon-di-sulphite is required. The Rayon Panel have recommended the production of 70 tons of viscose rayon per day. Three rayon factories of an aggregate capacity of 30 tons per day are being established in the Southern Zone and two in the Western

Zone. The South Indian Rayon Industry would thus require about 4,500 tons of carbon-di-sulphide per year and the chemical will be produced in the rayon factories in suitable units. The rayon factories to be established in the Western Zone would require about 3,600 tons of carbon-di-sulphide per year. Carbon-di-sulphide is also required in large quantities for the manufacture of carbon tetrachloride required in the vegetable oil industry as a solvent, in the solvent extraction process. Every zone in the country being an important centre of vegetable oil industry, there will be great demand for the solvent in the years to come, but here again it is difficult to assess the total requirements for carbon-di-sulphide. It may, however, be assumed to be of the order of another 20,000 tons per year.

24. The production of aluminium in India to-day is abut 7,500 to 10,000 tons per year and two factories, one in Bengal and the other in Travancore are in operation. The demand for the metal is on the increase and it will soon reach 20,000 tons per year. A new aluminium factory with a production capacity of 10,000 tons of virgin metal per year has been planned in the Western Zone and a similar one in the Southern Zone.

25. In the wake of the progress of Electro-metallurgical Industry especially of Aluminium Industry, manufacture of magnesium will receive considerable importance as aluminium and magnesium are the two important constituents of variousl ight metal alloys—duraluminium, magnaluminium, etc., which are coming into great prominence in recent times, in the development of aircraft, automobile, railway and shipbuilding industries. Magnesite is an important raw material for the manufacture of magnesium and is available in large quantities, particularly in the Southern Zone. With hydro-electricity available at cheap rates, manufacture of magnesium as well as light metal alloys becomes feasible.

26. In the following table we have summarised the trends of development of Heavy Chemical and Electro-chemical Industries. Column 2 indicates additional projected manufacture of various products during the next 5 or 10 year periods for which plans are definitely underway. Column 3 indicates targets of production for various heavy chemical and electro-chemical products, as recommended by the Industrial Panels of the Government of India.

TABLE II

Product	Additional Projected Production during the next 5 years (Tons per year)					Additional Production fixed by the Panel.
	Southern Zone	Western Zone	Northern Zone	Eastern Zone	Total	
Ammonia	26,160	..	..	..	26,160	15,000 (excluding the ammonia required for Ammonium Sulphate manufacture at Sindhri).
Sulphuric Acid	71,200	..	..	11,300	82,500	75,600
Caustic Soda	31,500	..	..	3,400	34,900	1,20,400
Ammonium Sulphate	50,000	..	..	3,00,000	3,50,000	The Government scheme is to produce 3,00,000 ton of ammonium Sulphate per year at Sindhri
Superphosphates	53,000	..	..	13,000	66,000	88,000
Soda Ash	1,30,000	..	..	..	1,30,000	1,96,000
Other Mineral Acids	5,500	..	..	..	5,500	2,500 (only Nitric Acid)
Mineral pigments, Miscproducts, in organic salts excluding common salt	16,000	..	..	6,774	22,774	32,000
Hypothon	4,500	..	..	..	4,500	..
D. D. T.	3,000	..	..	..	3,000	30,000
Urea	9,000	..	..	..	9,000	10,000
Formaldehyde	250	..	..	..	250	..
Calcuim carbide	2,000	..	..	..	2,000	7,000

Product.	Additional Projected Production during the next 5 years (Tons pey year)					Additional Production fixed by the Panel.
	Southern Zone	Western Zone	Northern Zone	Eastern Zone	Total	
Hydrogen Peroxide	250	..	..	..	250	400
Carbon di Sulphide	4,500	..	..	..	4,500	8,760
Aluminium	10,000	..	..	..	10,000	10,000
Magnesium	1,500	..	..	..	1,500	1,500
Artificial abrasives, Artificial graphite & graphite products.	2,000	..	..	..	2,000	2,000
Alcohol, acetic acid etc.	will be dealt with under Sugen & Fermentation Industry					
Ferro-alloys.	will be dealt with under Metallurgical Industries					

27. Details of increase in the production of various items of chemicals in the Western and Northern zones are not available. We, however, expect that during the next five years the production of the basic chemicals such as sulphuric acid, soda ash, caustic soda, etc., will at least be doubled. The most important feature of chemical industry in the Eastern Zone is coal carbonisation and coal-tar distillation. We shall refer to this in detail under Pharmaceuticals, Drugs and Fine Chemicals.

Assessment of manpower requirements and pattern of employment.

In column 2 (*e*) of Table II is indicated the projected additional output per year of the various heavy and electro-Chemical products during the next five year period. Excluding the output from the Sindhri Fertilizer Factory these total upto about 382,000 tons end-products only being considered. This column presents a picture, based on factual data of the trend of industrial development in the field of heavy chemicals in the country and relates only to such of the development projects as have been already contemplated or are in the course of execution. During the Survey, it was, however, observed that industrialists had not decided on their development projects, for various reasons. That the Government of India had not till that time clarified their Industrial Policy also provided grounds for the reluctance of the industrialists to indicate their future plans. There has consequently been many a gap in the data obtained during the survey. Furthermore, the expansion plans of the existing establishments would not and could not fully account for the overall development that would be required. The gap could only be bridged by taking note of the plans proposed by Industrial Panels. We, therefore, believe that the Industrial Panel Reports provide the best blue prints obtainable under the existing circumstances. We also observe that whatever industrial projects have been decided upon either by the industrialists or the by Government are, generally in accordance with the plans drawn up by the Panels. For the assessment of the manpower requirements we accept the targets of production recommended by the Panel as the basis. These are indicated in Column 3 as the 'additional production' over and above the present production, and total up to about 900,000 tons per year. On the basis of production to Personnel Ratio arrived at in para. 13 and assuming that the same ratio holds good for electro-chemical industries as well the total number of chemists and engineers required are 1800 and 900 respectively.

It must be pointed out at this stage that the targets of production envisaged by the Panel will not all be attained by setting up entirely new factories. Some of the existing units will be expanded to produce an appreciable part of the targets. This expansion will entail less technical manpower than would otherwise be if new units are to be set up. For the rest units with a larger production capacity than those in operation at present might be set up. These large units would also require less manpower than for smaller units with the same aggregate production.

28. We have therefore, to take into account all these and other similar factors in arriving at a final estimate of manpower requirements. We believe that allowing a margin of 20% for consequential reduction the total manpower required for the development of heavy chemical industry in the country during the next 5—10 year period is 1440 Chemists and 720 engineers.

29. It is of some importance to know the kind of engineers and chemists that will be required for the manufacture of various heavy chemical and electro-chemical products. In the table below an attempt has been made to indicate the types of personnel required for the manufacture of each of the ten groups of products, each group rquiring similar operations or processing.

TABLE III

Groups and products	Nature of processes involved	Special types of personnel required.
(a) Inorganic salts, superphosphates, soda ash, sulphuric acid and other mineral acids, hypothon, mineral pigments, ammonium sulphate.	Processes involving general inorganic reactions and general chemical engineering.	General Inorganic and Physical Chemists, Chemical and Mechanical Engineers.
(b) Caustic soda, hydrogen peroxide.	Processes involving electro-chemical reactions with particular reference to inorganic chemicals.	Electro-chemists, inorganic chemists, chemical and electrical engineers.
(c) Urea, ammonia	Processes involving high pressure synthesis	Physical chemists, Chemical and Mechanical Engineers.
(d) D. D. T.	Processes involving general organic reactions.	Organic chemists and Chemical or Mechanical Engineers.
(e) Alcohol, acetic acid and other organic acids.	Processes involving industrial fermentation.	Fermentation technologists, biochemists and chemical engineers.
(f) Aluminium, magnesium	Processes involving general inorganic reactions (for ALO 23 from Bauxite) electrolysis in the fused state, and electro-metallurgy.	Inorganic chemists, metallurgical chemists specialising in electro-metallurgy and electrical engineers.
(g) Formaldehyde, Organic compounds from calcium carbide.	Processes involving catalytic reactions.	Physical chemists and Chemical engineers
(h) Calcium carbide, artificial abrasives, artificial graphite, carbon-di-sulphide	Processes involving electro-thermics.	General inorganic chemists, electrical furnace technologists (engineer).
(i) Electrolytic organic compounds	Processes involving electro-chemical reactions with special reference to organic, compounds.	Electro-chemists with special knowledge of organic chemistry and general chemical or mechanical engineers.
(j) Ferro-alloys	Processes involving metallurgy and electrical furnace engineering.	Electrical chemists engineers with special knowledge of electrical furnaces and metallurgists.

30. It may be assumed that the ratio of personnel for any individual groups of products to the total is the same as that of the group to the aggregate production (end-products only) of the whole industry. We thus arrive at the following distribution of personnel among the various groups :

Group	*Personnel Required* *Chemists*	*Engineers*
(a)	1,112	556
(b)	193	97
(c)	40	20
(d)	48	24
(e)	..	..
(f)	18	9
(g)	..	..
(h)	29	14
(i) & (j)	..	..

31. Generally speaking, in all chemical factories at least 50% of the chemical personnel employed are for routine work and for the supervision of skilled workmen and, therefore, do not require to be specialists. They are usually graduates in chemistry taken into the industry as apprentices and trained for a particular line of work. Out of a total of about 1440 chemists required for the developments, about 827 may be considered as belonging to this category. Similarly 50% of the engineering personnel, *i.e.*, about 360 may be considered as belonging to the category required for day to day servicing, maintenance and operation of plants in the factory. For the group (*a*), from the nature of the processes involved, we might say that about 60% of the specialists required will be general inorganic chemists and the rest physical chemists. The chemical engineering and mechanical engineering personnel may be required on a 50 : 50 basis. Since for the manufacture of certain mineral pigments like zinc oxide red lead and lithophone, furnace technologists also are required at least 15 of the engineering personnel should have special knowledge of fuel and furnace technology. For group (*b*), electro-chemists and electrical engineers are required in greater number than inorganic chemists and chemical engineers respectively–may be as much as 70% of the total. Physical chemists form the bulk of the chemical personnel for group (*c*) while chemical and mechanical engineers or mechanical engineers, both with special knowledge of high pressure technique and engineering of gases comprise the Engineering personnel. Group (*d*) admits of few alternatives. For the manufacture aluminium and magnesium (group *f*) metallurgical chemists with special knowledge of electro-metallurgy are preferred. Since some stages of the process, especially the manufacture of aluminia from bauxite or from other aluminium-bearing minerals involve specialised inorganic reactions, inorganic chemists are also necessary; hence the proportion of metallurgical chemists to inorganic chemists may be taken as 60 : 40. Groups *g*, (*h*), (*i*) and (*j*) need no further explanations in respect of the personnel required.

It is to be mentioned here that, although we have classified the personnel required into a large number of types, in most cases a hard and fast classification is not necessary. However, the classification as made above may serve the useful purpose of providing a basis for formulating measures in respect of the necessary training facilities.

32. The following table summarises the conclusions arrived at in paras. 28–31 in respect of scientific and technical manpower requirements for the development of Heavy Chemical and Electro-chemical Industry in the country.

TABLE V

Requirements of personnel for the development of Heavy Chemical Industry.

Chemists		*Engineers*	
Junior Chemists or Operators	720	Junior Engineers or Operators	360
Executives or Senior Chemists or Specialists :		Executives or Senior Engineers or Specialists:	
Inorganic & General Chemists	378	Chemical Engineers	160
Physical Chemists	242	Mechanical engineers	148
Electro-Chemists	70	Electrical Engineers	40
Organic Chemists	24	Electrical Engineers with special knowledge of Electro-thermics.	7
Metallurgical Chemists with special knowledge of Electro-Metallurgy	6	Engineers with special knowledge of Fuel and Furnace technology.	5

NOTE.—The Ministry of Industry & Supplies have estimated the requirements as follows :—

Chemists		*Engineers*	
Senior Chemists	275	Chemical Engineers	150
Junior Chemists	650	Erection & Maintenance Engineers	275

Training of personnel in Industry

33. As seen from above, about 720 chemists and 360 engineers both belonging to the specialist or senior group will have to be trained in order to meet the needs of the development of the Heavy Chemical and Electro-chemical Industry in the country according to the recommendations of the Industrial Panels. For the development and implementation of the various development projects definitely contemplated, we need to train immediately 828 chemists and 418 engineers. The necessary training to be given to them would consist of both academic and practical aspects, the former in educational institutions and the latter in the industry. We shall deal with the academic training aspects under 'Higher Scientific, Technological and Engineering Education' at a later stage in the report and confine ourselves to the latter aspect in this section.

34. That the training of personnel in the chemical industry itself after the necessary academic training is most necessary for the proper development of the industry is admitted on all hands. Almost all the concerns which we contacted during the survey have expressed the view that pre-employment training of graduates is necessary to make them suitable for industrial occupation and are anxious that the gap should be filled by imparting adequate practical training to those who aspire to take to industrial occupation in the various lines of manufacture. Training in industry is best organised by selecting suitably qualified candidates, candidates who have received the necessary academic training in the various branches and assigning them to factories for an intensive practical training in the works for a period ranging from 6 to 12 months. The factories that are to be selected for the purpose should be in a position not only to provide the training facilities but also to supervise such training. There are about 20 prominent heavy chemical industrial concerns in the country which are in a position to provide industrial training facilities. Such facilities are summarised below zone-wise.

TABLE VI

Name of firm	Field of training	No. of candidates that can be trained
Southern Zone		
M/s Fertilisers & Chemicals, Travancore	Ammonia manufacture : Gas Division and synthesis division	12
M/s Mettur Chemical Corporation	Sulphuric acid and ammonium-sulphate manufacture	8
	Engineering Division	2
M/s Mettur Chemical Corporation	Caustic Soda and chlorine manufacture	2
	bleaching powder manufacture	1
M/s Mysore Chemicals & Fertilisers	Ammonia, sulphuric acid and ammonium sulphate manufacture	4
M/s Parry & Co., group of chemical and fertiliser concerns	Manufacture of fertilisers, acids and inorganic salts	2
Mysore Government Dichromate Factory	Manufacture of dichromates, chrome pigments etc.	8
Cordite Factory, Aravankadu	Manufacture of sulphuric acid and nitric acids ; manufacture of acetone.	6
	Manufacture of explosives and nitro-compounds	6

On the whole, the existing concerns in the zone can organise training of 52 candidates all of whom with the exception of two are chemists (inorganic, physical and electro-chemists) ; the lines of their manufacture being ammonia, sulphuric acid, ammonium sulphate, superphosphates, caustic soda and chlorine, dichromates, chrome pigments and inorganic salts. Except for two engineers, none of the concerns has indicated how many engineering personnel could be trained in each concern. We may assume that on the whole, about 25 engineers can be trained at a time.

In respect of other zones, detailed information is not available. However, in the following table is indicated the principal concerns in these zones, the branches in which training facilities are likely to be available and the number of men that could be trained. Some of the concerns have indicated that they would offer training facilities for candidates while others have not. We have already referred to this in our interim report with particular reference to such of the concerns as have adequate training facilities, but are not prepared to permit the use of such facilities for the training of personnel. We have also suggested in that report that a suitable legislative measure should, if necessary, be introduced to make it obligatory on the part of every industrial concern to provide industrial training facilities for candidates notwithstanding whether such candidates are required for employment at a later stage or not.

Name of firm	*Field of training*	*No. of candidates that can be trained* Chemists	Engineers
Northern Zone			
D. C. M. Chemical Works, Delhi	Manufacture of sulphuric and other mineral acids, inorganic salts and fertilisers	2	1
Shambunath & Sons, Ltd., Amritsar	Manufacture of sulphuric and other mineral acids, inorganic salts.	2	1
Cawnpore Chemical Works, Cawnpore	Manufacture of sulphuric and other mineral acids, inorganic salts, chromates and dichromates	3	1
S. P. Chemical Works, Ltd., Chhaharta, Amritsar	Manufacture of sulphuric and other mineral acids and inorganic salts	2	1
Eastern Zone			
Bengal Chemical and Pharmaceutical works Ltd., Calcutta	Manufacture of sulphuric and other mineral acids and inorganic salts	3	1
Rohtas Industries Ltd., Dalmianagar, Bihar	Manufacture of sulphuric and other mineral acids, alkali chlorine industry, bleaching powder and inorganic salts	5	3
Aluminium Corporation of India	Manufacture of aluminium	6 (Two out of whom are metallurgists)	5
Western Zone.			
Tata Chemicals, Mitapur	Manufacture of soda ash, caustic soda and marine salts	8	4
Dhranghra Chemical Works	Manufacture of soda ash and marine salts	4	2
Pioneer Chromate Works Ltd., Bombay	Manufacture of chromates and dichromates	2	—
Dharmsi Morarjee Chemical Co., Ltd.	Manufacture of sulphuric and other mineral acids, and inoganic salts	3	1
Messrs. Eastern Chemicals Ltd., Bombay	Manufacture of sulphuric and other mineral acids and inorganic salts.	4	2

35. Assuming that the duration of training in 'Chemical Industry' is about one year, the existing concerns in all the four zones put together can train during the next five years 480 chemists and 240 engineers, while the number of trained personnel for the various development projects contemplated for all the four zones far exceed the above number. However, training facilities will increase progressively as new concerns come up during the period or the existing ones put up additional plants under their development projects. The proposed five soda ash plants (with an aggregate capacity of about 130,000 tons of soda ash per year) when established, will provide adequate training facilities for a large number of inorganic and physical chemists and chemical and mechanical engineers. Similarly, the caustic soda factories, sulphuric acid, ammonia and fertiliser factories, and others which have been contemplated will provide training facilities for additional number of men. The management of some of the concerns which have definite development and expansion projects underway or under consideration have assured that there would be considerable increase in the training facilities in due course and that such training. (facilities could be readily available for the training of personnel.)

36. Special mention must be made here of the training of certain types of highly specialised personnel, required for the development of some special branches of chemical industry and for which facilities in the country hardly exist. There will be required chemists and engineers specialising in chlorination of rubber and rubber products, high pressure synthesis, electro-metallurgy, catalytic synthesis, electro-thermics, electrolytic organic reactions etc. required for the development respectively of manufacture of chlorinated rubber and like products, urea, magnesium, formaldehyde and organic compounds from calcium carbide, artificial abrasives and artificial graphite, carbon-di-sulphide and electrolytic compounds etc. These lines of manufacture being new to the country, there are few concerns which can provide training facilities and hence arrangements would have to be made abroad for the necessary training atleast in the initial stages.

37. All the industrial concerns have deprecated the idea of sending inexperienced and raw technical men abroad for training especially in academic institutions in the hope that, through such training, industry in the country would benefit. But they feel that there is genuine need for organising training abroad in certain specialised branches of the industry. In their opinion, such training should be arranged mostly in industrial concerns abroad and rarely in academic institutions, so that trainees may get real experience in works and, on their return, be able to handle similar projects in this country as well as train further batches of Indian personnel, if necessary.

38. Having noted these views of industry and taking into consideration the special lines of development, we give below the various subjects in which training will have to be organised abroad and the number of men to be trained during the next 5 year period in each subject.

TABLE VII

Lines of manufacture	Field of training	Personnel to be trained	
		Chemists	Engineers
Urea and other similar compounds	High pressure synthesis	4	2
Magnesium	Electrolysis in the fused state and electro-thermics	2	2
Formaldehyde and organic compounds from calcium carbide	Catalytic synthesis	2	1
Calcium carbide	Electro-thermics	4	4
Artificial abrasives, artificial graphite etc.	Electro-thermics	2	2
Carbon-di-sulphide	Electro-thermics	6	3
Electrolytic organic compounds	Electro-chemistry	4	2
Chlorinated rubber and like products, hypothon or high test bleach	Chlorination	3	..
Mineral pigments and other products	Fuel and furnace technology	2	2
Fertilisers (superphosphates and fused phosphates)	Acidulation and high temperature reactions	4	2
Alkali-chlorine industry	Electro-chemistry	3	2
Instrument technology with special reference to chemical industry	..	..	4
Factory safety engineering	..	..	4
Moving and handling in factories	..	..	4
Plant maintenance, high pressure technique and mech. engineering applied to chemical industry	..	..	6
Catalysis and corrosion problems and utilisation of waste gases	..	..	4
General factory maintenance and efficient audit	..	..	8
Gas Technology with special reference to the production, purification and utilization of producer gas, water gas etc. for heavy chemical industry, liquid fuel production, plastics and other lines of chemical industry.	..	4	2

Pharmaceuticals, Drugs and Fine Chemicals

39. The Pharmaceuticals, Drugs and Fine Chemicals Industry covers a wide range of products of direct benefit to mankind. These are derived from animal, vegetable and mineral raw materials. The various products are broadly classified into the following divisions.

Vegetable drugs or galenicals.—Products derived from vegetable or plant origin like alkaloids, glucosides, gums and resings, essential oils etc.

Inorganic fine chemicals.—Compounds of mercury, arsenic, bismuth etc.

Synthetic drugs or chemotherapeutics.—Sulphonomide compounds, thiozoles, anti-malarials like mepacrin, paludrin etc., barbiturates cardizoles, derivatives of arsenic, bismuth etc., synthetic insecticides, D. D. T., gammexane etc.

Biologicals.—Vaccine, sera, proteins and plasma, hormones, liver extracts etc.

Antibiotics.—Products derived from fungal and bacterial origin like pencillin, streptomycin etc.

Vitamins.—Vitamins A, B, C, and D derived from various sources like shark liver oil, synthetic products etc.

40. A number of specialised scientific and technical methods and processings are employed in the manufacture of the above products. Consequently the scientific and technical personnel required for the industry are of such specialist groups as organic chemists, specialising in plant chemistry and synthetic organic chemistry, inorganic chemists, bio-chemists, micro-biologists, bacteriologists, pharmacologists, veterinary and medical men.

Present position

41. The Pharmaceutical and Drug Industry in the country is still in its infancy and there are four principal concerns in the Southern zone, 4 in the Western, 7 in the Eastern and 3 in the Northern zones.

The following table shows the zone-wise distribution of the industry and brings forth the important features of the Industry on the qualitative side.

TABLE IX

Zone	Lines of manufacture	Quantity of production	Value
Southern (4 concerns)	B. P. preparations like tinctures, galenicals, liver extracts, tablets, etc., proprietories and a few chemicals like calcium lactate, gluconate etc., quinine salts from cinchona.	B. P. Preparations 720,000 lbs./year Galenicals 50,000 lbs./year	Not known
Eastern (7 concerns)	B. P. preparations like tinctures, galenicals, liver extracts, tablets, proprietories ; colloidal preparations, vaccines, sera, bacteriophage and other immunological preparations.	Not available	Rs. 22 lakhs.
Western (4 concerns)	Generally the same as above	Not available	Not availabe
Northern (3 concerns)	Manufacture of B. P. preparations and proprietories	Not available	Not available

From the above table, it is obvious that the Indian Pharmaceutical and Drug Industry as it exists to-day is confined principally to the manufacture of B. P. tinctures, drugs and galenicals of vegetable origin, liquid extracts of liver and chicken and a few fine chemicals all of which taken together form only a small part of the range and type of the industry outlined in para. 39 above. Chemotherapeutics or synthetic drugs, antibiotics, harmones and other biologicals and vitamins which are mile-stones in the conquest of disease are not being produced in any appreciable quantity. It should however be mentioned here that quite a good quantity of vaccines and sera for public immunotherapy are being produced by Provincial and Indian State Governments in certain zones in their Public Health Departments. These are also being produced at least by four industrial concern in the Eastern zone. Standardised shark liver oil is being produced in considerable quantities by certain Provincial Governments

and Governments of Indian States as a part of the activity of their Fisheries Department. The quinine factories of Governments at Naduvattam and Darjeeling are meeting an important need of the country in the matter of quinine salts. The major portion of quinine (100,000 lbs.) produced in the country comes from these two factories. In addition India also produces some of the important alkaloids in considerable quantities. These are strychnine (15,000 lbs.), santonin (2,000 lbs.), ephedrine (3,000 lbs.), caffeine (20,000 lbs.) and morphine (2,000 lbs.).

43. These processes employed in the above lines of manufacture are mostly confined to simple standardised operations like grinding, extraction, concentration etc. and many proprietory preparations contain ingredients which are imported from abroad but not manufactured in the country.

Technical Staff employed

44. Details of technical staff employed in pharmaceutical concerns and their production figures are not available for all the zones. In the case of this industry, however, production to personnel ratio would serve no useful purpose as the industry is still undeveloped and the assessment of personnel required will consequently have to be made from other considerations.

Development and Expansion

45. The development and expansion of the industry in the country during the next 5 or 10 year period; may be considered in the light of the projects contemplated by the existing concerns as well as in the light of the recommendations made by the Panel on 'Pharmaceuticals and Drugs'. As regards the former, in the Southern Zone almost all the concerns have contemplated doubling the production of the various products—tinctures, galenicals, liver extracts, tablets and other B. P. preparations. One of the concerns has under consideration projects for largescale manufacture of malt extract from cereals and of calcium lactate by the fermentation process. It also contemplates producing pharmaceutical yeast and glandular products. Manufacture of silver, mercury and iron compounds as well as a few other fine chemicals of pharmaceutical importance has also been planned. Establishment of another quinine factory for the production of about 100,000 lbs. of quinine per year has been proposed in the Annamalais Hills in the Southern Zone. In the matter of synthetic insecticides, one of the heavy chemical concerns has planned for the production of 1,000 tons of D. D. T. per year and we have referred to this already in the section on 'Heavy Chemicals'.

46. In the Eastern Zone, all the concerns have contemplated increasing the production of various pharmaceutical preparations in which they are engaged at present, as well as undertaking the manufacture of certain new products like synthetic drugs, asperin, phenacetin, arsenic and antimonial compounds and vitamin concentrates. In the field of biology it is contemplated to increase the production of glandular products. Manufacture of sulpha drugs, barbiturates and a few other synthetic drugs has been proposed by one of the concerns.

47. In the Western Zone also it is proposed to increase the production of various pharmaceutical preparations, especially of B. P. preparations. Manufacture of some fine chemicals such as calcium lactate, calcium gluconate, potassium permanganate has been planned. Protein hydrolysates for oral and intravenous uses is an interesting item of manufacture proposed by a concern in this zone.

48. The development plans of pharmaceutical concerns in the Northern Zone envisage manufacture of liver extracts, harmones and chloroform along with various B. P. preparations.

49. With a view to making India self-sufficient in regard to the more important synthetic drugs and fine chemicals, the Panel on 'Fine Chemicals, Pharmaceuticals and Drugs, have recommended that the production of two categories of products should be taken in hand immediately, *viz.*

(*1*) those products which are essential for guarding the health of the people and for warding off infectious diseases; and

(*2*) those products for which India already has or can easily develop raw materials in abundance.

Under the first category come the sulpha drugs, antimalarials (quinine, mepacrine, pamaquine, paludrin etc.) penicillin and streptomycin, arsenicals and D. D. T. Under the second category come the drugs of vegetable and animal origin such as quinine, emetine, morphine, caffein, ephedrine, santonine, essential oils etc., biologicals, vaccines, sera, liver extracts, glandular products and the like. The following targets have been fixed by the panel for the next 10 year period.

TABLE X

Quinine		2 million lbs. per annum in 15 years
Morphine		3,000 lbs. per annum in 10 years
Codein		1,500 lbs.
Caffein		30,000 lbs.
Strychnine		16,000 lbs.
Ephedrine		5,000 lbs.
Santonine		3,000 lbs.
Emetine		2,000 lbs.
Balladona pulverata		50,000 lbs.
Mepacrine		160,000 lbs.
Pamaquine		5,000 lbs.
Sulpha drugs		500,000 lbs.
Procaine hydrochloride		500 lbs.
Cocaine hydrochloride		100 lbs.
Sulfarsphenamine Neoarsphenamine P—carbamino phenyl —arsenic acid		100,000 lbs. (1 lak lbs.)
Percaine		25 lbs.
Atrophine		150 lbs.
Veronal and Luminal		25 tons.
Hexamine		50 tons.
Argenti Proteins		5 tons
Asperin		50 tons
Shark liver oil		1 milion gallons average pote of 6,000 units per annur
Vitamins A. B. Group C. D.		.. ..
Penicillin		100,000 million units.
Adrealine		50 lbs.
Disoxycortisterone		10 lbs.
Other harmones		As much as possible.
Liver extracts—injectable		15 million ccs.
Oral	Liver extracts	200 million ccs.
D. D. T.	Insecticides	30,000 tons.
Pyrethrum	Insecticides	50,000 tons
Paris green	Insecticides	5,000 tons
Freon.	Refrigerator chemicals	400,000 tons
Methyl chloride	Refrigerator chemicals	200,000 tons
Sodium thiosulphate		1,000 tons
Sodium sulphite		300 tons
Sodium bi-sulphite		800 tons
Pyrogallol		20 tons
Hydroquinine		50 tons
Amidol		5 tons
Metol		20 tons
Phenol		250 tons
Phenetidine		200 tons
Phenacetin		50 tons
Paramisidine		50 tons
Benzaldehyde		20 tons
Benzoic acid		20 tons
Acetophenone		10 tons
Resorcinol		25 tons
Cresols		1,000 tons
Xylenols		500 tons
Pthalicanhydride		20 tons
Pthalic acid		100 tons
Acetic anhydride		250 tons
Monochloracetic acid		100 tons
Citric acid		500 tons
Lactic acid		100 tons
Steric acid		1,000 tons
Formaldehyde		1,000 tons
Ethylene oxide		50 tons
Diethyamine		50 tons
Malonic Ester		100 tons
Acetoaeticester		150 tons
Formic Ester		100 tons
Urea.		100 tons
Thiourea		60 tons
Guanidine Nitrate		200 tons
Glucose		500 tons
Lactose		750 tons

Thionyl chloride		100 tons
Phosphoric acid		100 tons
Phosphorous Oxychloride		450 tons
Barium peroxide	Inorganic fine chemicals	100 tons
Phosphoric acid	Inorganic fine chemicals	100 tons
Ethyl alcohol		10 million gallons
Methyl alcohol		1,200 tons
Butyl and Iso-butyl alcohols		500 tons
Amyl and Iso-amyl alcohols		500 tons
Acetone		1,000 tons
Methyl Ethyl acetone		200 tons
Ethyl ether		250 tons
Chloroform		500 tons
Carbon-tetra-chloride and tetra-chlorethylene		250 tons
Acetic acid		1,000 tons
Ethyl ,butyl and amyl acetates		1,500 tons
Benzene		5 million gallons
Toluene		500,000 gallons
Pyridine		250 tons
Nitro-benzene		200 tons
Trichlorethylene		20 tons
Glycol		1,000 tons
Metallic sodium	Miscellaneous products	500 tons
Activated carbon	Miscellaneous products	250 tons
Agaragar	Miscellaneous products	10 tons
Starch	Miscellaneous products	1,000 tons

50. The above targets are for the whole of the country for the next 10 year period. Various efforts are now being made both by established concerns and by new ones to attain the above targets at least in the matter of some of the more important products such as vegetable alkaloids, synthetic drugs, harmones etc. The Government Quinine Factory at Naduvattam is now producing about 50,000 lbs. of quinine salts and under the development project, another factory capable of producing 100,000 lbs. per year is proposed to be established. Assuming that this factory will come into being soon, the total output of quinine from the Southern Zone will be about 150,000 lbs. per year. Pyrothrum cultivation has been taken in hand in various parts of the country and it may be expected, conditons favouring, that a substantial part of the targets proposed by the panel would be attained during the next 10 year period. The cultivation of crude drugs like ipecac, nuxvomica, ephedra is also being carried on a large scale, and some of the important alkaloids including caffein from tea and coffee wastes, are being produced in the country as mentioned at para. 41.

51. The manufacture of chemotherapeutics or synthetic drugs is largely dependent on dyestuff intermediates and the industry will develop in proportion to the development of dyestuff industry. At present, there is no dyestuff industry to speak of in the country but certain proposals are underway for the establishment of the industry with the aid of foreign technical talent. The essential raw materials for dyestuffs industry are to be obtained from coaltar distillation. In India, over 90% of the coal distilled is coked in high temperature coke ovens, the main product (coke) being to a very large extent consumed in the iron and steel industry. The quantity of coal distilled in India is comparatively small and is limited to that processed by the Bombay and Calcutta companies. The potential coking capacity of coke ovens in India is about 3.5 million tons of coke per year. The coal-tar produced represents only approximately 2.5% by weight of the coal distilled in the coke ovens. In 1941, the quantity of coal-tar produced in India was about 80,000 tons of which approximately 60,000 tons were distilled. But due to coal and fuel shortage, this quantity has undergone substantial reduction and the amount of the tar now available for distillation has dropped to 50% of the pre-war figure. The war-time production of low boiling tar bases in the country was as follows :—

Napthelene	600 tons per annum
Phenol	50 tons per annum
Cresols	100 tons per annum

The potential output of phenol from coal-tar is not considerable and the greater part of the estimated demand of phenol will have to be met from synthetic production. In the case of cresols, it is possible to meet 50% of the estimated demand. Of the several benzol recovery plants which are in

operation, two important ones are situated at the two main steel works. The Tata Iron and Steel Co., Jamshedpur and Indian Iron and Steel Co., Hirapur. These recovery plants are the property of the Government of India but are operated on behalf of the Government by the respective steel companies, under agreement for a certain number of years. The capacity of these benzol recovery units is as follows—

Benzene	2.1	million gallons per annum
Toluene	42	milion gallons per annum
Solvent Naptha	0.1	million gallons per annum

The estimated demand for these products is 5 million gallons of benzene, and half a million gallons of toluene during the next 10 year period for the pharmaceutical industry. A deficit of about 3 million gallons of Benzene will have to be made up by installing more recovery units. The Mohindra Committee (The Indian Coal Fields Committee) whose recommendations have been accepted by the Government have strongly pleaded for the installation of recovery units at every carbonisation centre. This is necessary not only from the production of essential raw materials for the pharmaceutical industry but also for the dyestuff industry. At the same time, investigations are proceeding on low temperature carbonisation of Indian coal as this will result in larger yields of the important distillation products for the drug industry.

52. In the matter of antibiotics, the manufacture of penicillin has been contemplated both by the Government and the industrialists. Certain provincial governments and governments of Indian States are already manufactureing shark liver oil of standard quality on a large scale. Increase in the production of shark liver oil is contemplated by all these governments during the next 5 years. Utilisation of slaughter-house wastes for the manufacture of harmones has been investigated by the Council of Scientific and Industrial Research and several firms have plans under-way for the exploitation of the process. Of the several organic solvents, ethyl alcohol is being produced in large quantities by many sugar concerns in the country and we shall refer to this subject in detail under 'Sugar and Molasses Industry'. Acetone is being produced at the Cordite Factory in Aravankadu in considerable quantities by a catalytic process from ethyl alcohol. The same process may be employed every where in the country with advantage for the manufacture of the required quantities of acetone. Small quantities of chloroform and ether are being produced by certain firms and it should not be difficult to increase production to meet the required demand. The manufacture of carbon-tetrachloride and trichlorethylene should be taken up as a sequel to the development of alkali-chlorine industry.

Assessment of personnel and pattern of employment

53. The personnel required for the development of the pharmaceuticals, drugs and fine chemicals industry in the country may be assessed from a consideration of the trends of development outlined in paras. 45—52.

54. For determining the personnel required for the targets fixed by the Panel, we have classified the various products into several groups, namely alkaloids, synthetic drugs, vitamins, harmones, liver extracts, organic and inorganic fine chemicals, coal-tar intermediates etc. as shown in table X.

To take Alkaloids first the Panel has fixed 2 million lbs. as the target of quinine for the next 15 years. If we take 1·3 million lbs. as the proportionate target for the next 10 years, Indian production should increase by 1·2 million lbs. during this period, since 100,000 lbs. are at present being produced in the country. The production of quinine is, however, governed chiefly by the extent of cultivation of cinchona which in turn is governed by various factors such as soil, climate and other agricultural factors. If the target fixed by the Panel is to be achieved the area under cinchona cultivation should increase twelve-fold. Such a large increase in cultivation is unlikely to happen especially becuase the areas suitable for cinchona cultivation in the country are limited. We do not anticipate more than a six-fold increase in the cultivation of cinchona during the next 10 years. Besides, new synthetic antimalarials such as Paludrine etc. will limit the importance of quinine therapy against malaria. Taking all these limiting factors into consideration, we expect that the increase in the production of quinine in the country during the next 10 years will not be over 0·6 million lbs. The Naduvattam Factory which produces 50, 000 lbs. of quinine/year employs a staff of 4 chemists. On this basis the production

of 0·6 million lbs. of quinine requires 48 chemists, half of whom are pharmaceutical or organic chemists and the rest junior chemists. Since the extraction of cinchona alkaloids on a large scale by modern methods involves some chemical engineering operations also 2 chemical engineers and 4 engineering operators also would be required.

The manufacture of other alkaloids involves solvent extraction, filtration, purification and crystalisation and chemical assay operations of a somewhat specialised kind. The panel has fixed 60,500 lbs. for various alkaloids while the country produces, 37,000 lbs. at present. We may take 23,500 lbs. as the additional production to be attained during the 5—10 year period. Taking an average figure of 1% recoverable alkaloidal content for caffeine, morphine, emetine, strychnine, etc. in the plant material, nearly 2·35 million lbs. of the plant materials will have to be treated for the manufacture of 23,500 lbs. of alkaloids per year, *i.e.*, about 8,000 lbs. of plant materials per day. Assuming that these 8,000 lbs. are treated in units each of 1,000 lbs. which includes extraction, purification, concentration and crystalisation of the alkaloids, solvent recovery and assaying, the personnel required for each unit will be about 3 chemists and the total technical staff required would be about 24 chemists. Some chemical engineers also, say about 2 would be required. Of the chemical personnel, 15 should be organic chemists or pharmaceutical chemists with special knowledge of chemistry of plant products and especially of alkaloids. The rest are junior chemists or operators.

The target of production of synthetic drugs is 1·05 million lbs./year or about 3,500 lbs./day. Considered on the basis of 7 units, each of about 500 lbs. and with 5 senior chemists—who should be organic chemists with specialised knowledge of synthetic organic chemistry, the staff required for the above target is 35 organic chemists. A corresponding number of junior chemists or operators also would be required. The engineering personnel would consist of about 2 chemical engineers. Staff requirements for a penicillin factory—with a production capacity of 40 U. S. A. billion units of penicillin per month—which is the smallest economical unit, employing 8 tanks, each tank with a capacity of 8,000 gallons, are as follows :—(Furnished by Mr. P. Shankara Murthy who has specialised in the manufacture of penicillin and other antibiotics in U. S. A. on behalf of the Tatas).

Senior Executive Staff.—

Bio-chemists	3
Mycologists	2
Bacteriologist	1
Chemical Engineer	1
Mechanical Engineer	1
Electric Engineer	1

Junior Technical Staff.—

Chemists	32
Engineers	6
Pharmacological assistants	2

We may assume that the above would be the staff requirements for our projected penicillin factory, even though its output may be less than the optimum according to the U. S. A. standards.

Staff requirements for liver extracts, harmones, shark liver oil and other biologicals is estimated to be as follows :—

Biochemists	20
Junior Chemists	20

In the matter of insecticides, D.D.T. has already been dealt with under heavy chemicals. The target of production of Pyrethrum is 50,000 tons of dry flowers, but this item does not entail any technical personnel.

The staff requirement for the production of refrigerator chemicals, organic and inorganic fine chemicals including photographic chemicals, solvents and miscellaneous products fixed by the Panel is estimated to be as :

Organic & Inorganic Fine Chemicals ;

15 Senior organic chemists.

4 Senior physical chemists.

8 Inorganic chemists.

30 Junior chemists or operators.

2 Chemical engineers.

8 Junior engineers or operators

Solvents excluding ethyl alcohol and coal-tar distillation products and intermediates for drug industry

15 Organic chemists.

4 Physical chemists.

30 Junior chemists or operators.

2 Chemical engineers.

10 Junior engineers or operators.

The staff requirements for ethyl alcohol will be considered under 'Sugar and Molasses Industry'

Miscellaneous products, etc.

4 Organic chemists.

2 Electro-chemists.

2 Physical chemists.

8 Junior chemists.

The production of pharmaceuticals and drugs for the market entails, besides the manufacturing operations, assaying also chemical and biological for the standardisation of the products. Every pharmaceutical concern, therefore, requires chemical and bio-assayists. It is, however, not possible to assess the requirements for this category of personnel for the development of the industry in the country., But it is felt that the minimum requirements in this respect would be about 30 assayists of each category.

55. In the following table is given a consolidated statement of requirements for scientific and technical personnel for the development of drugs, pharmaceuticals and fine chemical industry in the country for the next 5 or 10 year periods.

Requirements for Personnel for the development of Pharmaceutical, Drug and Fine Chemical Industry

Organic Chemists/Pharmaceutical Chemists	108	
Biochemists	23	
Inorganic Chemists	8	
Physical Chemists	10	
Electro-chemists	2	
Mycologists	2	For the penicillin Factory
Bacteriologists	1	For the penicillin Factory
Pharmacologists	2	For the penicillin Factory
Mechanical Engineers	1	For the penicillin Factory
Electrical Engineers	1	For the penicillin Factory
Chemical Engineers	11	
Junior Chemists	188	
Junior Engineering Operators	28	
Assayists (Chemical)	30	
Assayists (Biological)	30	

56. It is to be noted that of the above personnel in the second group, 40 organic chemists should possess specialised knowledge of the chemistry of plant products, especially of alkaloids, and about 50 organic chemists in synthetic organic chemistry.

Industrial training.

57. Undeveloped as the industry is in the country, specially in the field of chemo-therapeutics, biologicals & antibiotics, the industrial training facilities available are limited in scope. Manufacture of synthetic drugs, biologicals and antibiotics has been developed only in foreign countries. Without specialised training of our technical personnel in these fields, particularly in industrial concerns, there is little likelihood of our being able to make any progress in the establishment of the industry in the country. It is, therefore, essential that such specialised training should be arranged with foreign concerns abroad. Taking into consideration the scope and extent of development of the industry in the country during the next 5 years, we feel that training abroad will have to be organised in the following subjects and for the number of men indicated.

Note.—The Ministry of Industry and Supplies estimate the requirements as follows :—

Organic, Pharmaceutical & Biochemists	40
Chemical Engineers	10
Mechanical Engineers	10
Junior Chemists	100

TABLE XIII

	Subject	No. of men to be trained
1.	Chemo-therapeutics or synthetic drugs	10 organic chemists.
2.	Glandular products or harmones and other biologicals.	5 Biochemists.
3.	Catalytic synthesis of certain organic fine chemicals and solvents	3 Physical chemists and 2 chemical engineers. (These should be trained in a tea),
4.	Manufacture of antibiotics like penicillin	2 teams, each consisting of 3 biochemists, 1 mycologist, 1 bacteriologist, 1 chemical engineeers.
5.	Chemical, biological and pharmacological assay of pharmaceuticals and drugs.	5 biochemists. pharmacologists.

58. The following training facilities are available in the existing industrial concerns in the country.

TABLE XIII

Industrial concern	Field of training	No. of persons that could be trained per year
Southern Zone		
M/s. Parry & Co. Pharmaceutical Works at Trivandrum	General Pharmaceutical preparations such as B. P. tinctures, tablets, liquid extracts etc. and a few fine chemicals.	8
M/s. Mysore Industrial Testing Laboratory		
M/s. Andhra Pharmaceutical Works		
Govt. Quinine Factory, Naduvattam	Extraction & manufacture of quinine salts from cinchona.	4
Eastern Zone		
Bengal Chemical & Pharmaceutical Works Ltd., Calcutta	General pharmaceutical preparations such as B.P. tinctures, liquid extracts etc., and some inorganic & organic fine chemicals ; extraction & purification of alkaloids.	2
Albert David & Co., Calcutta	Ditto.	2
Standard Pharmaceutical Works, Calcutta	Pharmaceutical products including sera, vaccines and chemotherapeutics or synthetic drugs.	2
Bengal Immunity Co., Calcutta	Biological & biochemical preparations	4
Indian Medical Supply Laboratory, Calcutta	General pharmaceutical preparations, vitamin concentrates.	2
East India Pharmaceutical Works, Calcutta	Biological & biochemical preparations ; B.P. tinctures & other pharmaceutical preparations.	1
Birla laboratories	Biological & pharmaceutical preparations	3
Smith Stainstreet & Co., Ltd. Calcutta	General pharmaceutical products	2

(In addition to the above 30 operators or foremen could also be trained in the above concerns.)

TABLE XIII—*Contd*

Industrial concern	Field of training	No of persons that could be trained per year
Northern Zone		
John Jason & Co., Delhi	B. P. preparations & drugs	1
Hind Chemicals, Kanpur	B. P. preparations and drugs	1
The Lesco Chemical Works Ltd., Kanpur	Ditto.	1
	Western Zone	
Alembic Chemicals Ltd., Baroda	B. P. preparations, chloroform, ether & other Pharmaceutical preparations.	2
M/S Cipla & Co., Fombay	Synthetic drugs & chemo-therapeutics	2
Teedington Chemical factory, Bombay	Vitamin concentrates, B. P. preparations & biologicals.	2
Zandu Chemical & Pharmaceutical Works	General pharmaceutical preparations	1

58. The available facilities are adequate for the training of candidates every year but the field of training mostly suited to the manufacture of general pharmaceutical preparations as much as B.P. tinctures tablets liquid extracts and a few fine chemicals. Facilities for the training of personnel in the manufacture of biologicals and immunological preparations are available only in 2-3 concerns, and in the manufacture of chemo-therapeutics or synthetic drugs in 2 concerns. The scope of training in synthetic drugs manufactur is also very limited as only a few simple items are being produced in the country at present.

SOAPS, OILS AND FATS

Present position

59. The Soaps, Oils and Fats Industry has reached a state of no mean development in the country and a large number of concerns, big and small are engaged in the field. The chief reasons for the development of the industry are the ralatively simple operations involved in their manufacture, small capital investments required for an optimum unit of the industry, ease in obtaining the necessary plant and equipment and the country's favourable position in respect of raw material resources—vegetable oils and animal fats. The recent introduction of hydrogenated oils as an article of food in place of animal fats like *ghee* and butter has given a tremendous impetus to the hydrogenated oil industry in the country.

60. The Soaps, Oils and Fats Industry as it exists in the country produce washing, toilet and industrial soaps and general toilettries and also refined and hydrogenated oils for edible vanaspati and other purposes.

61. The total annual production of Soaps of all varieties in the county has been estimated at 140,000 tons and there are 15 principal concerns in the country distributed zone-wise as follows :
other purposes

Southern zone	4	concerns.
Eastern zone	5	concerns.
Western zone	4	concerns.
Northern zone	2	concerns.

62. In passing, mention may be made of the Kerala Soap Institute of the Government of Madras which is both a manufactory and a technical institution—the latter for the training of students in the technology of soaps, oils and fats and the former to provide factory or industrial training facilities to the students. The manufacturing section also produces goods for the market.

Technical Staff

63. From a sample survey of five principal concerns, it has been found that for the production of 1,000 tons of soap per year 3 chemists and 1 engineer are generally required.

Hydrogenated Oils

64. It has been estimated that the total installed capacity of hydrogenated oils factories in the country is about 370,000 tons per year including the capacity of the 16 new units recently sanctioned by the Government. It is understood that many of these new units have not yet been commissioned. Consequently, we may estimate that the actual production of hydrogenated oils in the country is about 3·1 lakhs tons. It has been ascertained from the technical executives of some of the prominent hydrogenated oil factories in the country that for a hydrogenated oil factory with a production capacity of 10 tons per day or 3,000 tons per year (the factory year being 300 working days), the staff requirements a e—2 senior chemists, 8 junior chemists and 2 engineers.

Development and Expansion

65. The present annual production of soaps in the country is about 140,000 tons. This means 0·75 lb. or 12 oz. of soap per head of population. The consumption of soap will increase to a much larger extent in the near future. The chief factor, however, limiting the development of Soaps and Oils Industry is the shortage of vegetable oils and fats and caustic soda. The moment adequate supplies of these two essential raw materials are assured, the industry will develop on an extensive scale. India is one of the principal oilseed producing countries of the world and has occupied hitherto a prominent place in the oilseed trade of the world. The important place which oilseeds occupy in the agricultural economy of the country including the Indian States can be appreciated from the fact that nearly 8% of the total net area under cultivation or about 23 million acres are used for raising oil-bearing crops. The annual production is about 7 million tons of oilseeds valued at about Rs. 240 crores. Sometime back India used to feed the markets of the world with her oilseeds. But in recent years, the position has changed considerably. A large number of industries dependent on these agricultural products have since come up in the country resulting in a decline of our exports of oilseeds. With further industrialisation there will be a further decline in our exports and there may even be shortage of vegetable oils in the country it self. As a matter of fact, shortage of cocoanut oil is being felt. In the matter of alkali also, indigenous production is far short of demand, but projects are under way for increasing its production during the next 5 years. Keeping in view all these factors we may confidently expect that the production of soap in the country during the next 5 years will only be doubled. As a matter of fact, most of the established concerns are contemplating doubling of their output. The Panel on the Industry has suggested a target of 300,000 tons/year. This is a modest estimate and it should be possible for the industry to attain this target during the next 5 years. We may, therefore, take 160,000 tons of soap year as the additional projected figure of production.

66. In the matter of hydrogenated oils, the Government of India have approved a scheme of development which envisages production of hydrogenated oils at about 400,000 tons per year during the next 5 year period. The present installed capacity is 370,000 tons leaving thereby a balance of 30,000 tons to be made up by the installation of new units. Of this present capacity of 370,000 tons 16 new units recently sanctioned by the Government with an aggregate production capacity of about 120,000 tons are not yet fully in operation and 8 units are yet to be established. We may, therefore, for the purpose of this report, take 90,000 tons per year as the additional target of production for hydrogenated oils to be attained during the next 5 year period.

Assessment of personnel and pattern of employment

67. The scientific personnel required for the Soaps and Hydrogenated Oils Industry consist of chemists with a basic knowledge of the chemistry and technology of soaps, oils & fats and general mechanical or chemical engineers. Even for the top executive and senior posts in the Soap Industry, practical experience rather than high academic training and theoretical knowledge is required.

68. The requirements for technical personnel in the country during the next 5 years may be assessed on the basis of the additional targets of production mentioned in paras. 66 & 67 and according to the production to personnel ratio stated in paras 64 & 65 above. In our final estimates for soap industry we have to make allowances for a reduction of about 20% for possible expansion of existing units which would necessarily require less scientific manpower.

TABLE XIV.

Requirements for personnel

Line of manufacture	Additional projected targets of production (including targets fixed by the Panel and Government)	Requirements of personnel	
		Chemists	Engineers
Soap*	160,000 tons per year	384	128
Hydrogenated Oils*	90,000 tons per year	300	60

69. In the Hydrogenated Oil Industry two out of every ten chemists are senior executive chemists and the rest junior chemists or operators. We may assume that in the Soap Industry, the chemical staff comprises senior and junior chemists in equal proportion. On this basis, the total technical staff required for Soap & Hydrogenated Oils Industry may be grouped as follows :

TABLE XIV

Senior or executive chemists (Chemical technologists, Soaps, Oils & fats)	252
General mechanical or chemical engineers	94
Junior chemists or operators	432
Junior engineers or operators	94

**Note*.—The Ministry of Industry and Supply estimate the requirements as shown below :—

	Chemists	Engineers
Soap	Senior 20 Junior 100	Consulting Engineers 20
Hydrogenated oils	Senior 20 Junior 100	Consulting Engineers 20

Industrial training

70. The industrial training facilities available in the principal soap concerns in the country are as follows :—

TABLE XV

Concern	Field of training	No. of candidates who could be trained
Southern Zone		
Mysore Govt. Soap Factory	Manufacture of soaps	3 chemists.
M/s Tata Oil Mills Co.	Manufacture of soaps and hydrogenated oils	6 ,,
M/s Mettur Chemical Corporation	Manufacture of soaps and hydrogenated oils	2 ,,
Mysore Vegetable Oil Products Ltd., Bangalore	Manufacture of hydrogenated oils	2 ,,
Eastern Zone		
Rohtas Industries	Manufacture of soaps & hydrogenated oils	3 ,,
Bengal Chemical & Pharmaceutical Works Ltd.	Manufacture of soaps	2 ,,
Bharat Vegetable Products	Manufacture of hydrogenated oils	2 ,,
Calcutta Chemicals	Manufacture of soaps	2 ,,
Western Zone		
M/s Tata Oil Mills, Bombay	Manufacture of soaps	4 ,,
M/s Lever Bros Ltd., Bombay	Manufacture of soaps and hydrogenated oils	8 ,,
Godrej Soap, Bombay	Manufacture of soaps	3 ,,
Swastik Oil Mills, Bombay	Manufacture of soaps & oil products	3 ,,
Northern Zone		
Modi Soap Industries, Modinagar	Manufacture of soaps and hydrogenated oils	4 ,,
D. C. M. Chemical Works, Delhi	Manufacture of soaps and hydrogenated oils	4 ,,

Assuming that the period of training is 6 months for the manufacture of soaps and for hydrogenated oils, the available facilities are adequate for the training of about 96 senior technical personnel every year. It is to be noted that some of the concerns can provide training only in Soap technology, some only in oil technology and others in both. In organising industrial training in these concerns a suitable arrangement will have to be worked out whereby the training comprises both soap and oil technology.

No specialised training of engineers for this industry is called for. General engineering education and training in mechanical, or chemical engineering subjects should suffice.

71. We have discussed with the chief soap and oil industrial concerns in the country the need for training of personnel abroad but have received few useful suggestions in the matter. We, however, feel that while it is unnecessary to arrange for the training abroad in the usual methods of soap and hyrdrogenated oils manufacture, there is need for having a few persons trained in the continuous saponification process of soap manufacture which has been developed to a considerable extent only in foreign countries. It is considered necessary to have about 4 chemical technologists trained abroad in this field to meet the needs of the Indian Industry during the next 5 years.

Essential Oils

72. We cannot conclude our report on 'Soaps, Oils & Fats Industry' without a reference to essential oils. Essential oils as distinct from vegetable or fixed fatty oils are derived from vegetable sources. They are volatile and are extracted from roots, stems, barks, leaves, flowers, seeds and peals and have an aromatic odour. Essential oils have a wide range of application and are used in the manufacture of soaps, perfumery, cosmetics, pharmaceutical preparations, confectionary, aerated waters, disinfectants etc. In India except sandal wood oil, most of the essential oils are being produced all over the country in a crude and unscientific manner and on a cottage industry basis, generally ; and the industry as a whole is in an undeveloped state. Trade in these essential oils in India is valued at about Rs. 2 to 3 crores per year. Sandal wood oil is being produced principally in Mysore State on modern scientific lines as a state enterprise. This factory produces over 150,000 lbs. of B.P. quality East Indian Sandal Wood oil valued at Rs. 60 lakhs and employs 5 qualified chemists and 12 mechanics who hold diploma in engineering. A good part of the oil is exported to foreign countries (where the Mysore Sandal Wood Oil is highly prized) and the rest is consumed in the country. Some of the soap factories also distill small quantities of several essential oils for their own purposes employing scientific methods.

73. The trend of development of the Essential Oil Industry during the next 5 or 10 year periods is hard to define. However, important as the industry is in the industrial economy of the country, it is necessary that the industry should develop along right scientific lines and on an adequate scale. Both the Essential Oils Advisory Committee of the Council of Scientific & Industrial Research and the Panel on 'Soaps, Oils & Fats' have broadly outlined how the industry should be developed. The latter has fixed targets of production for the next 5 or 10 years, especially in the matter of some of the important products like lemon grass oil, Palmarosa oil, eucalyptus oil, *khus* oil, linaloe oil and oils of geranium, cynamon leaf etc. Some pioneering efforts have been made in certain parts of the country for the cultivation of the plants and for the distillation of the oils. With extensive and intensive cultivation of the more important plants on a planned basis, the targets of production fixed by the Panel could be attained in a large measure.

74. The manufacture of essential oils is carried out by four well-known methods :—

(*a*) Water or steam distillation,
(*b*) expression,
(*c*) enfleurage, and
(*d*) solvent extraction.

For employment of all these methods in the Essential Oils Industry, we require technical personnel—mostly chemists with a basic knowledge of the chemistry of essential oils and with practical experience. Since we are at this stage unable to assess the scale or the extent of development of the industry during the next 5 or 10 year periods as well as the size of individual units that are likely to be established, we cannot indicate to any degree of accuracy the requirements for personnel But as a first approximation, we suggest that 30 chemists or chemical technologists trained in the distillation and purification of essential oils will be required.

75. As regards industrial training facilities for the Essential oil Industry, it is understood that some of the soap factories in the country as well as other concerns are carrying on essential oil distillation on a scientific basis, though on a small scale. It is likely that the facilities available at these establishments could be utilised for the industrial training of candidates. It is also understood that the Mysore Government Sandal Wood Oil Factory can train 8 candidates every year in modern methods of distillation of essential oils.

76. Indian Industry would benefit much if some suitably qualified personnel are trained abroad, and especially in Grasse in Southern France, where the Essential Oils Industry has been largely developed. In the initial stages the following number of candidates will have to be thus trained:

Agricultural & botanical aspects of cultivation of essential oil-bearing plants	4 agricultural or botanical personnel.
Manufacture of essential oils and isolation and purification of constituents	4 organic chemists.

PAINTS & VARNISHES

Present position

77. The last great war gave a considerable impetus to the development of 'Paints and Varnishes Industry' in the country and the present production of paints & enamels is estimated to be 50,000 tons/a year and of varnishes 25 lakhs gallons including 1·35 lakhs gallons of superior quality varnishes. There are about 30 principal concerns distributed amongst the 4 zones as follows —

Southern Zone	2
Eastern Zone	16
Western Zone	9
Northern Zone	3

manufacturing ready mixed oil paints in various popular shades, anti-corrosive paints and special paints conforming to standard specifications, camouflage paints and varnishes of oil and spray types. Recently, some concerns have also started the manufacture of special paints, enamels and varnishes including certain types of electric insulation varnishes, intro-cellulose lacquers etc.

78. Of the raw materials, pigments both natural and synthetic are being produced by five concerns, 3 of which are in the Eastern Zone, one in the Southern and the other in the Northern Zone. The total annual production of synthetic pigments has been estimated at :—

Zinc oxide	400 tons
Lead pigments— Read lead, white Lead litharge, Lead chrome etc.	4500 tons

Drying oils and dryers which constitute more than 50% of the raw materials for the paint and varnish industry, are also being produced by a number of concerns which are engaged in the manufacture of ready mixed paints and varnishes. All the other raw materials, especially resins like shellac are being produced in the country in considerable quantities as forest produce. India holds practically a world monopoly in shellac. Of the two important solvents namely, ethyl alcohol and turpentine, both are being produced in considerable quantities in the country—the former by the fermentation of molasses, which is a by-product of the sugar industry and to which we shall refer under 'Sugar and Molasses Industry. Turpentine is being distilled at two principal factories in the Northern Zone. The estimated production of resin and turpentine in the country is 1,000 and 4,000 tons respectively.

Technical Staff employde

79. A considerable number of chemists, & chemical technologists and some general mechanical engineers are employed in the industry in the country. Our information being incomplete in respect of the production and the technical staff employed in each individual concern, it is difficult to arrive at a production to personnel ratio for paints, varnishes and enamels—a ratio which might be taken as representative of all the concerns in the country. It has, however, been ascertained from a reliable source engaged in the industry that the technical staff required for a paint and varnish factory with a production capacity of 2,000 tons of finished products per year, is 8 chemists and 7 engineers, 50% in the former category and about 70% of the latter category of personnel being operators.

Development and Expansion.

80. Almost all the existing concerns in the country contemplate increase in production and propose starting as well, new lines of manufacture. Some new factories are also being established and will go into production soon. The factors limiting the development of the industry being few or none at all, we have reasons to believevthat during the next 5 years, the development and expansion of the industry will take place generally in accordance with the recommendations of the Panel, which envisages the doubling of production. The increase in the production of paints & enamels will be about 50,000 tons which may leave us a considerable margin for export. This increase in production is likely to be achieved by increasing the production of the existing concerns and by installing new units, each with a capacity of 5 tons per day.

81. Corresponding to the increase in the production of paints, enamels & varnishes, the production of some finished raw materials—such as lithopone, zinc white, lead pigments, titanium pigments, resins solvents will also increase. The manufacture of titania pigments from the monizite sands has been planned for in Travancore and we have referred to this under 'Heavy Chemicals'. Manufacture of lithopone also has been contemplated by one or two concerns in the country. The following table summarises the trends of development of the industry during the next 5 years :—

TABLE XVI

Product	Increase in production
Paints & enamels	50,000 tons/year
Varnishes—special types	4 lakhs gallons
Pigments :	
Lithopone	4 5,000 tons
Lead pigments	3,500 tons
Titanium pigments	3,000—5,000 tons
Drying oils	15,000 tons.
Solvents :	
Ethyl alcohol	
Acetone	
Acetone butyl & amyl alcohols & others.	
Synthetic resins	500 tons
Cellulose esters	15,000 lbs.

Pattern of employment and assessment of personnel

82. Chemists and chemical technologists with both academic training and practical experience in the manufacture of paints, varnishes and lacquers are mainly required in the 'Paint & Varnish Industry' since the progress of the industry depends to a great extent on continuous application of scientific research and knowledge, it is essential that the senior or executive staff should be well-qualified chemists on the academic side as well. The manufacture of raw materials for paints, varnishes and lacquer industry such as, for instance, pigments, solvents, cellulose esters, resins synthetic as well as from natural products require personnel of different kinds. Inorganic and physical chemists with knowledge of inorganic chemical technology are required for pigments ; organic chemists and fermentation technologists for solvents, organic and physical chemists with training in the manufacture of plastics of high polymers for synthetic resins. Though not to the same extent as in the Heavy Chemical or the Sugar Industries, engineers have a definite part to play in the running of paints and varnishes industry. Modern paint and varnish making machines are of a specialised kind and many of them, like roller mixers etc., have been likened to precision lathes and similar machines. Their operation, maintenance, repairs etc., in a large establishment require the services of general mechanical or chemical engineers who have had experience or training in the field.

83. In the assessment, the requirements for personnel for the manufacture of varnishes have been excluded as varnish making is only part of the activity in the industry. The personnel required for titanium pigments have also been excluded as these have already been considered under 'Heavy Chemicals'. As the major portion of the solvents are to be manufactured from molasses, we shall consider the personnel required under Sugar & Molasses Industry. Cellulose Esters may also be excluded as the projected quantity could be produced as pointed out by the Panel, at the Cordite Factory at Aravankadu with the available facilities.

84. From a consideration of the trends of development of the industry during the next 5 years as outlined in the preceding paras, the following is expected to be the requirements for technical personnel after making allowances for the expansion of the existing units.

TABLE XVII

Requirements for personnel for Paint Enamel and Varnish Industry

Chemical technologists in Paints, Enamels & Varnishes	80
Chemists or Chemical technologists with specialised training in the manufacture of inorganic pigments	10
Fuel and Furnace technologists for pigments manufacture	4
Organic and/or physical chemists with specialised training in the manufacture of synthetic resins and resins from natural products	10
General mechanical or chemical engineers	40
Junior engineers or operators	100
Engineering operators	90

Industrial training

85. The following industrial training facilities are available in the existing concerns in the country, given zone-wise :

TABLE XIX

Industrial concern	No of persons that could be trained at a time
Southern Zone	
1. Mysore Govt. Paint & Lac Works	3 at present and more later on when its development project is carried out.
2. Kanakamba Paint Works	2
Eastern Zone.	
1. Shalimar Paint, Colour & Varnish Co.	6
2. Jenson & Nichlson Ltd.	5
3. Swaika Paint, Colour & Varnish Co.	3
4. Macfarlane & Co.	3
5. Anglo Brothers Ltd	2
6. Napier Paint Works	2
7. Murarka Paint Varnish Works	3
8. Hadfields Ltd.	3
9. Hoyle Robson & Barnet & Co.	3
10. Solar Paint & Varnish Co.	2
11. P. C. Chanda & Co.	2
12. Jay Engineerings Works	2
Western Zone.	
1. Goodlas Wall & Co.	4
2. Elephant oil Mills Ltd.	2
3. Cooper & Co.	2
4. Hardcastle Ward Ltd.	2
5. John Fleming & Co.	1

Note.—The Ministry of Industry & Supply have estimated the requirements as follows :—

Chemical Technologists in Paints, Varnishes and Enamels	20
Chemists with Specialised training in the manufacture of Inorganic pigments	8
Chemists Specialised in the manufacture of synthetic Resins	4
Engineers	25
Machine Operators	200

On the basis that the period of training in all aspects of paints, enamels and varnishes is about one year, the available facilities are adequate for the training of about 52 persons every year. The number could be doubled if the period of training is cut down to six months.

As regards training abroad, the following summarises the requirements.

Special field of training.	No. of men to be trained abroad.
1. Manufacture of special lines of paints, varnishes and enamels.	8 chemical technologists
2. Manufacture of lithopone and other special inorganic pigments	2 „ „
3. Manufacture and operation of paint & varnish machinery	2mechanical or chemical engineers.
4. Manufacture of synthetic resins and resins from natural products for the enamel and varnish industry	4 organic chemists

Plastics Industry

86. Plastics Industry has two distinct aspects, viz., manufacture of resin and moulding powder on the one hand and of moulded products on the other. At present in India, the Industry is confined chiefly to the latter. Resin and moulding powder are being produced only in small quantities and the indigenous production has been estimated at not more than 60 tons of powder per year. The Plastic Moulding Industry has, however, advanced on some scale and there are about a dozen moulding concerns in the country which produce such plastic articles as ash trays, cups, saucers, soap boxes, combs, electrical goods etc. The Panel on 'Plastics Industry estimates that about 600 tons of moulding powder are being annually imported into the country and that there are at present about 75 presses engaged in compression moulding capable of handling a total tonnage of about 1000 tons of moulding powder. The majority of these presses are operated by human labour and out of date. The maximum rating (total pressure) of any single press is only about 100 tons which is much smaller than that used in moulding plants abroad. The Panel also estimates that there are about 6 injection moulding presses of small capacity for moulding thermo-plastic articles and about 220 dies in all, the only existing dies for injection moulding being those for combs and bottlecaps.

Development and Expansion

87. The poor state of development of the Plastics Industry in the country may be attributed chiefly to lack of necessary chemical raw materials, technical 'know how' and processing plant and machinery. These factors, however, will no longer be operative in the years to come. Technological and scientific research now in progress will give the industry considerable impetus. Heavy Chemical and other Chemical Industries which have been planned on a fairly large scale will provide the principal raw materials required for Plastics Industry. The Panel has recommended the following targets of production for the next 5 year period, in respect of some of the commonest types of resins.

Phenol Formaldehyde resins	1500 tons
Urea formaldehyde resins	500 „
Cellulose Acetate resins	1000 „
Cellulose Nitrate resins	2000 „

88. Plastics Industry consists of an impressive range of synthetic resins of which the above are only a few. Melamine, furfuralphenol, Nylon, Polythene, Alkyde, Silicones and polystyrenes are some of the important resins which have come into great prominence in recent years. The production of these resins, however, require a very wide range of raw materials which are not at present being produced and also specialised technical and scientific knowledge which we do not possess at present. Consequently, the development of Plastics Industry for the manufacture of these resins can only take place as researches in plastics in the country progress and the necessary raw materials are produced in the required quantities by our Chemical Industry. For the next 5 year period therefore, the types of resins and their targets of production as suggested by the Panel may be considered as the first stage of development of the Industry.

89. There is considerable scope for the development of Plastics Industry in the country utilising available natural resources such as shellac, vegetable oils, Bhilawan, cashew nut shell liquid etc. Research investigations which have been successfully carried out at various research laboratories have established the possibility of development of the industry along these lines.

90. The Motion Picture Industry occupies a significant place among the industries of the country, and it is reported that more than 42 studios and 350 units are engaged in film production in the country, and that about 4 million worth of imported raw films are consumed every year by this industry. The Panel, expects, that, with the rapid growth of the film industry during next 5 years which is certain to happen, consumption of motion picture raw film will be about 200 million ft. or 25 million sq.ft. In addition to this about 25 million sq. ft. of photographic, graphic and art films will be required. The total requirements at the end of the next 5 years, has, therefore, been estimated at about 50 million sq. ft. There being no Raw Film Industry in the country at present, the Panel has stressed that the establishment of Celluloid Industry or Raw Film Industry in the country is urgent and imperative, and has recommended that a factory capable of producing 50 million sq. ft. of raw film of all types per year should be established immediately.

Assessment of Personnel

91. In the absence of any factual data relating to Plastic & Celluloid Industry, we may assess the requirements for personnel for the development of the industry on the following basis.

The production of 1,500 tons of Phenol-Formaldehyde and 500 tons of Urea Formaldehyde resins may be carried out in 5 units, each unit handling 3,000 lbs. of resin per day. On the assumption that the finished moulding powder contains 50% resin, the output of finished moulding powder would be 6,000 lbs. per day in 6 batches, each batch of 1,000 lbs. The staff required for each unit would be 6 senior Plastic Chemists or Chemical technologists, 2 Chemical Engineers, 12 Junior Chemists or operators and 6 Junior Engineers or operators.

The production of 2,000 tons of Cellulose Nitrate and 1,000 tons of Cellulose Acetate may be carried out in 2 units, each of 5 tons per day. The staff requirements for each unit would be 5 senior chemists or chemical technologists, 10 junior chemists, 2 chemical engineers and 5 engineering operators.

The staff requirements for the Raw Film Factory with a production capacity of 50 million sq.ft. per year may be estimated as 15 senior chemists or chemical technologists, 5 physicists, 60 junior chemists or operators, 10 mechanical & electrical engineers, 5 chemical engineers and 50 junior engineers or operators.

The requirements for staff for the manufacture of resins from natural products need not be made at this stage as this line of industry will develop only consistent with the successful application of research results.

92. The following gives an overall estimate of the requirements for technical personnel.

TABLE XX

Requirements for personnel for Plastics & Celluloid Industries for the next 5 years.

Senior Staff.	
Plastics Chemists or Chemical technologists in Plastics	50
Physicists	5
General mechanical engineers	10
Chemical engineers	20
Junior Staff.	
Junior chemists or operators	140
Junior engineers or operators	90

Industrial training :

93. Undeveloped as the industry is in the country at present the available facilities are very poor for the industrial training of personnel in the manufacture of synthetic resins and raw film. Consequently for the development of the industry, the necessary training will only have to be organised in industrial concerns abroad. The following summarises our requirements in this respect for the next 5 year period.

Subject.	No. of men that could be trained.
Manufacture of synthetic resins, such as Phenol Formaldehyde, Urea Formaldehyde, Nylon, Polythene, Venyl resins etc.	6
Fabrication and operation of Plastic Moulding Presses and other processing machinery	4 engineers.
Manufacture of raw film	2 teams each
each team consisting of one chemical technologist, one physicist and one engineer	
Advanced training in High Polymers	5 chemists.

Note.—The Ministry of Industry and Supply estimate the requirements as follows.—

Chemical technologists in Plastics	15
Engineers	20
Operators	60

B. *Sugar, Molasses and Fermentation industries.*

1. Manufacture of sugar and products obtained by the formentation of molasses such as alcohol, food yeast,citric, lactic and gluconic acids etc, will be considered in this sub-section. Although these two groups of products have nothing in common so far as the technical or scientific aspects of manufacture are concerned, they belong to one industry, *viz.*, Sugar. For, molasses which is a by-product of sugar industry is the starting material for the manufacture of alcohol, food yeast and other products of fermentation ; and unless molasses are economically utilised, not only will their disposal become a problem for the sugar industry but also the economics of sugar manufacture will be adversely affected. As will be explained later, the manufacture of alcohol and other products of fermentation from molasses occupies a very significant and important place in the general industrial development of the country. Alcohol is reqired in very large quantities not only as a solvent in pharmaceuticals & drugs, paints & varnishes and other industries but has also great possibilities as an alternate fuel to petrol, in respect of which our resources are poor.

Present position :

2, Sugar Industry is one of the few well-established industries in the country and is generally well-distributed in the major part of the country. Consequently, it is also one of the largest employers of technical talent, especially chemists and engineers. Before the war, India had become self-sufficient in respect of its sugar requirements ; indeed in certain years production was in excess of consumption. Imports were small and were confined to maritime states. The demand for this commodity has since grown considerably owing to the general growth of the population, the increase in industrial and urban population and improvement in the purchasing power of a large section of the population with the concomitant changes in their standard of living. The number of concerns engaged in sugar production in the country is indeed large ; and these comprise both small & big ones classified on the basis of the cane crushing capacity. All concerns with a cane crushing capacity of more than 250 tons but less than 800 tons per day come under the former category and the rest under the latter. It is to be noted that most of the sugar factories in the country work only during the cane season. The theoretical production capacity of the existing vacuum pan factories manufacturing sugar directly from cane was over 1.4 million tons before the partition of the country, but the maximum production in any year was only 1.242 million tons. This is largely due to irregular supply of cane to the factories, shortage of fuel and fall in recovery. It has been estimated that the normal capacity of the Indian Sugar Industry with its present location, equipment and efficiency and under existing conditions of agricultural economy and transport for sugar cane is only about 1.084 million tons. As a result of partition, we have lost only a very small number of sugar mills and that too with an insignificant production capacity (not more than about 40—50,000 tons/year). Consequently, it may be taken that the normal production capacity of Indian Sugar Industry is about 1·04 million tons year.

3. The utilisation of molasses for the manufacture of alcohol is not being carried out by all the sugar concerns. India produces about 400,000 to 500,000 tons of molasses per annum. Molasses contain a large amount of fermentable sugar. One ton of molasses gives approximately 66 gallons of alcohol. The total molasses resources of India are, therefore, capable of yielding the oretically 33 million gallons of alcohol if the entire quantity of molasses is fermented. It has been decided to step up the production of sugar in India to 1·6 million tons per annum in the near future. This will give an additional 130,000 tons of molasses from which another 8 million gallons of alcohol can be obtained. There are about 30 principal distilleries in India capable of producing nearly 16 million gallons of alcohol per year. Out of these, 12 are power alcohol distilleries with a capacity of 9·2 million gallons. 4 more power alcohol distilleres are under construction wth an aggregate production capacity of 3·7 million gallons of power alcohol per year. Other products of molasses fermentation such as for instance lactic, cytric & acetic acids, amyl, & butyl alcohols are not being produced in any substantial quantity. Manufacture of food yeast is a recent development and is still confined to small-scale and pilot plant scale production for 2 sugar factories.

4. The following table summarises zone-wise the present position of Sugar & Fermentation Industry analytically.

TABLE I

Zone	No. of sugar factories with cane crushing capacity between 250 & 800 tons/days	No. of Sugar factories wth cane crushing capacity of 800 or more tons per day.	Average annual production of sugar	No. of distilleries	Rectified spirit production capacity (B.G. gallon)
Southern	10	3	1·04 million tons	4	1·44 million gallons year.
Western	11	4		4	1·95 million gallons
Eastern	22	20		5	1·62 million gallons
Northern	48	44		18	8·94 million gallons

Techn ical Staff employed :

5. Owing to the large number of concerns engaged in the manufacture of sugar, it has not been possible to cover all of them individually in the survey. However from a close study of the conditions obtaining in two principal concerns with a production capacity of over 60,000 tons of sugar per year and 3.025 million gallons of rectified spirits, it has been found that the following personnel to production ratio obtains in the Indian Sugar Industry, in general.

5 Chemists and 5 engineers produce 10,000 tons of sugar per year, and

3 chemists and 3 engineers produce one million gallons of alcohol per year.

Some of the sugar factories have on their technical staff, argricultural experts also but for the purpose of this report, we ignore this category of personnel as agricultural scientists are not in any way connected with the production operations etc. in the sugar industry.

Development and Expansion :

6. Rather than considering the development and expansion of sugar industry in the country during the next 5 years either zone-wise or individual concernwise, an overall picture can be presented in the light of the recommendations of the Panel on 'Sugar, Alcohol and Food Yeast Industries.' The only limiting factory in the development of sugar industry is the availability of sugar cane. The total area under cane cultivation in the country is about four million acres. With the acute scarcity of food crops it is very unlikely that more land would be brought under cultivation for cash crops and especially sugar-cane. Although a large number of irrigation schemes have been planned in almost all the Provinces and States,

it is very unlikely that these will materialise during the next 5 years to cause any considerable increase in the acreage under sugar cane cultivation. Any increase in sugar production in the country during the next 5 years can only be through more intensive cultivation of the land already under cultivation as well as through small marginal increases in the total acreage under cane cultivation. But the consumption of sugar in the country in the coming years will certainly increase with the increase in urban population and the general rise in the standard of living of the people. At the same time, it is also necessary that the export of sugar to neighbouring countries should be maintained at a satisfactory level. Considering all these factors, the Panel has recommended that the production of sugar should increase to 1·6 million tons by 1950. Although this target was fixed for undivided India, it will largely hold good for the present Indian Union as the total production of sugar factories outside the Union is small. We may, therefore, assume 1·55 million tons as the target of production during the next 5 year period. As has been stated earlier, the normal capacity of Indian Sugar Industry with its present location, equipment and efficiency and under the existing conditions of agricultural economy & transport for sugar cane is, according to the Panel, about 1·084 million tons for undivided India or 1·04 million tons for the Indian Union. The Panel expects that by 1950 it will, by development of sugar cane, construction of roads in factory areas, shifting of certain units to more suitable sites and improvement in manufacturing efficiency, increase by 170,000 tons to 1·25 million tons for undivided India, or say, to 1·2 million tons for the Indian Union. The difference between the present production and the target for the next 5 year period should, the Panel recommends, be covered both by increasing the cane crushing capacity to 800 tons of all such factories, as are of less than this capacity and by the establishment of new units. From a general survey of the development projects of the existing sugar concerns, we believe that the development of sugar industry in the country will follow the recommendations of the Panel and the target of production fixed by the Panel being modest and commensurate with the prevailing conditions will be attained.

7. The manufacture of alcohol by the fermentation of molasses is an important aspect of Indian Sugar Industry. For one thing, alcohol or rectified spirit is required in large quantities to meet the needs of pharmaceuticals & drugs, paints & varnishes, lacquers and of so many other industries. For another, 99·8% alcohol known as power alcohol when mixed with petrol is a good fuel for internal combustion engines. Industries which will consume alcohol are being greatly the developed. We have already indicated in our section on 'Pharmaceuticals & Drugs' that over 10 million gallons of rectified spirit would be required in the country during the next 5 years for these industries. The installed capacity of the distilleries in the country is about 14 Million gallons per year, the actual production depending on the supply of molasses etc. It is admitted on all hands that it is desirable to develop the power alcohol (99.8% alcohol) industry in the country with a view primarily to establishing an alternate source of motor fuel partially to replace petrol, the indigenous supply of which in the country is short, and also of utilising by-product molasses profitably. A mixture of 20% power alcohol with 80% petrol has been found most suitable for use as motor fuel. Some provinces and states have already legislated for the admixture of petrol with power alcohol in the above proportion not only to relieve petrol shortages but also to encourage indigenous alcohol industry. It is expected that all other provinces and states in the country will follow suit. The Dominion Parliament also has recently passed a legislation to the same effect. Several committees set up by the Government of India have estimated that at least 20 million gallons of power alcohol per year should be produced in the country during the next 5 years. The present power alcohol production capacity is 1·75 million gallons although only one million gallons are actually being produced. It should however, be possible to attain these targets of production utilising all the by-product molasses, now being produced as well as likely to be produced during the next 5 years as a result of the increase in the production of sugar.

8. Closely associated with the Molasses Fermentation Industry is the manufacture of organic acids such as lactic, citric & acetic acids, butyl and amyl alcohols and food yeast all of which belong to the field of Industrial Fermentations. Lactic and citric acids are important products in 'Pharmaceuticals & Drug Industry' and acetic acid is an organic acid of general importance and finds application in numerous fields. Butyl and amyl alcohols are important solvents in 'Varnish & Lacquer Industry'. Food yeast is the latest synthetic chemical food with high nourishment value. We have already referred to lactic and citric acids in the section on 'Pharmaceuticals & Drugs'. For butyl alcohol, the target of production for 'Paints & Varnishes Industry' is about 60,000 gallons. As regards food yeast, the Food Ministry has considered a scheme for establishing a factory for the production of 3,000 tons of food yeast per year, but

the Panel on 'Sugar Industry' has not favoured the establishment of one single unit for producing such a large quantity. It has instead recommended that Government should encourage sugar factories or other manufacturers to put up small units with a production capacity of 1 ton day or higher. We have reasons to believe that the development of food yeast manufacture will generally follow the recommendations of the Panel. As a matter of fact, several sugar concerns have projects underway for putting up 1 ton day units. We may, therefore, take for purposes of this report that the production of food yeast in the country during the next/ 5 years will be about 3,000 tons/year in 10 units, each unit with a production capacity of 300 tons/year.

9. The following table summarises the possible development of 'Sugar & Fermentation Industries' in the country during the next 5 years :—

TABLE II

Product	Increase in production
Sugar	350,000 tons/year
Power alcohol	19 million gallons/year
Butyl alcohol	6,000 gallons/year
Food yeast	3,000 tons/year (in 10 units).

Pattern of employment and assessment of personnel

10. We have already said earlier in this sub-section that sugar, alcohol, food yeast etc. belong to two distinct and different lines of manufacture entailing equally distinct and different types of executive or special technical personnel. On the chemical side, the personnel required would consists of sugar chemists or chemical technologists specialised in sugar manufacture and fermentation technologists or biochemists specialised in fermentation industry. On the engineering side, the personnel required would consist of general mechanical engineers with experience in sugar machinery operation and maintenance and chemical engineers. The engineering personnel, however, merge into one single category, *viz.*, mechanical or chemical engineers with experience in the engineering aspects of both sugar and fermentation industries. We may assume that 50% of the chemical and engineering personnel required for sugar manufacture belong to the junior or operator class.

11. The requirements for personnel for the projected development of sugar, alcohol and other products in the country during the next 5 year period may be determined on the basis of increase in the production stated in table II and the production to personnel ratio mentioned in para. 5. Butyl alcohol may be considered along with rectified spirit and power alcohol, since all these products are allied and the processes of manufacture substantially the same. As regards food yeast since the industry has not developed in the country, no factual data are available on which we might base our calculations in respect of personnel required for the projected manufacture of 3,000 tons per year. However, it has been ascertained from experts in the line that for an yeast plant of capacity 1 ton per day or 300 tons per year, the staff requirements are for 2 bio-chemists or fermentation technologists with specialised training in the manufacture of yeast, 3 junior chemists or operators, 1 microbiologist or bacteriologist, 1 chemical engineer preferably with training in refrigeration engineering and 2 junior engineers or operators.

TABLE III

Requirements for personnel for Sugar, Alcohol and Food Yeast Industries.

Sugar.—	
Chemical technologists in sugar manufacture	88
General mechanical engineers with experience of sugar industry	88
Junior chemists or operators	87
Junior engineers or operators	87
Alcohol.—	
Fermentation technologists or biochemists with experience in Fermentation Industry	29
Chemical Engineers	29
Junior chemists or operators	28
Junior engineers or operators	28

Food Yeast.—

Biochemists or fermentation technologists with specialised training in the manufacture of food yeast	20
Microbiologists or bacteriologists	10
Chemical engineers	10
Junior chemists or operators	30
Junior engineers or operators	20

Industrial training

12. Since the number of concerns engaged in the industry is large, it is unnecessary to state here the training facilities available in each concern, individually. Generally speaking, almost all the concerns are at present providing training facilities and are likely to provide for larger numbers, if necessary. There are atleast 50 principal sugar concerns and each of them can train a minimum of 3 chemists and 3 engineers. Consequently, the available facilities are adequate for the training of 150 chemists and 150 engineers in a year or for 750 chemists and 750 engineers during the next 5 years. As regards Fermentation Industry, there are over 15 principal distilleries and each distillery should be able to train 2 chemists and 2 engineers every year, or 150 chemists and 150 engineers during the next 5 years.

Note.—The Ministry of Industry & Supplies estimate the requirements for the development of *Alcohol* and Fermentation Industries as follows :—

Fermentation Technologists	15
Engineers	30
Operators	30

13. The available training facilities would suffice for the personnel that are required for Sugar and Alcohol Industries but not for the projected manufacture of food yeast. In para. 11 we have shown the probable requirements for staff for the manufacture of 3,000 tons of food yeast per year. According to these requirements, we have to train for the executive or senior posts in the yeast factories 20 biochemists or fermentation technologists and 10 chemical engineers. Since the Yeast Industry is yet to be developed in the country properly, it would be difficult to arrange for the necessary training in a satisfactory manner at present. Since the industry is yet to be established progressively during the next five years we should make a start with the training of the personnel required. For this, it is necessary in the initial stages at least to train 4 teams of biochemists and chemical engineers in factories abroad, especially in Jamaica (where a 4,000 ton factory is in operation) so that these might be trained in the large-scale manufacturing operations, fabrication of yeast plant and equipment, and other related matters. These teams on their return could handle these several yeast projects in the country and also train the necessary additional personnel. Each of these teams may consist of 2 biochemists or fermentation technologists and one chemical engineer.

14. Fermentation Industry based on by-product molasses will play a large role in the industrial development of the country. Besides rectified spirit and power alcohol, several other products of importance such as butyl and amyl alcohol, acetone, organic acids, etc. could be produced from molasses by fermentation methods, as we have mentioned already. There is a growing demand for these products and it has been envisaged that the Fermentation Industry in the country should develop for the manufacture of these products as well. Specialised scientific knowledge and experience are required in the manufacture of these products and the industry has developed only abroad particularly in the U.S.A. It would be in the interest of the Indian Industry to train a few of our men abroad in the field of Special Fermentations. This view is equally shared by the industrial concerns of the country who have also suggested that it would be desirable to train some Indian agricultural personnel in sugar cane cultivation also in Java. For the next 5 year period, the following indicates our requirements in the matter of training of Indian personnel abroad:—

Food Yeast manufacture	Two teams, each consisting of 2 biochemists and 1 chemical engineer (in Jamaica).
Special Fermentations	6 Fermentation Technologists or Biochemists (in U.S.A).
Agricultural aspects of sugar cane cultivation	5 graduates or post-graduates in agriculture (in Java).

C.—Paper, Boards and Chemical Cotton

Present Position

1. Paper Industry in India has reached comparatively a satisfactory state of development, though not on a scale commensurate with our requirements. The present estimated production of all varieties of paper excluding newsprint is about 87,500 tons per year and of straw and other varieties of board about 42,000 tons. Consumption of paper being in excess of present production, paper continues to be imported in considerable quantities. In the matter of newsprint, especially indigenous production being nil, the country has to depend entirely on imports. The zone-wise distribution of 'Paper and Board Industry' is given in the following table : (From the panel Report which excludes the Sirpur factory which is in Hyderabad).

TABLE I

Zone	No. of principal mills		Average annual production capacity	
	Paper	Board	Paper	Boards
astern	6	5	60,000 tons/year	20,000 tons/year
Western	3	3	4,200 tons/year	5,200 tons/year
Northern	3	5	14,600 tons/year	23,000 tons/year
Southern	3	..	10,000 tons/year	*Nil*

Total production capacity—88,800/year.

Handmade paper in small quantities is also being produced on cottage industry basis but for purposes of this report, cottage industries are excluded. Manufacture of board, especially strawboard from straw and other agricultural wastes has reached a satisfactory state of development, during the short time the industry has been in existence. The concentration of Board Industry is chiefly in the Northern Zone wherein perhaps the first board factory was started in the country. Eastern Zone comes first in the matter of paper production.

Technical Staff employed

2. The production capacity of Indian Paper Mills varies between very wide limits—from 1,200 tons to 30,000 tons per year, and the staff employed in any two factories for the production of a certain quantity of paper is not the same. Consequently, it is difficult to arrive at a production to personnel ratio, a ratio which might be taken as representative for the entire industry. However, from the data relating to 4 principal concerns each with an annual production capacity ranging between 3,500 and 10,000 tons, we find that the total technical manpower required for the production of about 5,000 tons of paper per year is 10 chemists and 8 engineers. We may for purposes of this report accept 5,000 tons as the average or medium production capacity of a paper mill.

The requirements for the production of about 18,000 tons of boards are 3 chemists and 3 engineers.

Development and Expansion

3. As has been stated earlier, the present production of paper is inadequate to meet the requirements. There is a great shortage of this useful commodity all over the country and the demand for paper will increase further as the educational standards of the people improve. It has been estimated that the *per capita* consumption of paper in India is a little over one lb. as compared to 152 lbs. in U.K. and 174·5 lbs. in the U.S.A. These figures bring out prominently the state of literacy in the country as well as the large scope for the development of paper industry that would result when the various educational development plans materialise. A large number of mills have contemplated increase in the production of paper during the next 5 years, and some new mills have also been proposed to be established. Taking into consideration the availability of raw materials, water, power, chemicals etc.

we feel that Paper Industry will develop considerably during the next 5 year period. The Panel on 'Paper, Pulp Board and Chemical Cotton Industries' have estimated that the anticipated annual consumption of paper including newsprint would be about 280,000 tons in 1951 and 422,000 tons in 1956. In a plan which the Panel has worked out for the development of the industry and which has been accepted by the Government, it has been envisaged that the indigenous production of paper should be increased to 189,000 tons by 1951 and 352,000 tons by 1956 and the balance should be met by imported paper.

* NOTE.—The Ministry of Industry and Supply state that the staff required for an average paper mill consists of one Chief Chemist, one Assistant Chemist, three Shift Chemists, one Chief Engineer, one Assistant Engineer and three Shift Engineers.

TABLE II

Type of product	Approximate present production in tons/year	Anticipated annual consumption in 1951 in tons	Anticipated annual consumption in 1956 in tons	Projected annual production		Balance to be met by imports	
				1951	1956	1951	1956
Writing and Printing paper of all varieties	75,000	125,000	200,000	110,000	200,000	15,000	*Nil*
Cheap Wrapping paper	*Nil*	60,000	60,000	24,000	50,000	36,000	10,000
Kraft paper	10,000	20,000	40,000	20,000	40,000	*Nil*	*Nil*
Sand paper	Very small quantity.	7,000	10,000	7,000	10,000	*Nil*	*Nil*
Grease-proof paper including vegetable parchment	*Nil*	2,000	4,000	2,000	4,000	*Nil*	*Nil*
Miscellaneous types including cellophane	2,500	6,000	8,000	6,000	8,000	*Nil*	*Nil*
Newsprint	*Nil*	60,000	100,000	20,000	40,000	40,000	60,000
TOTAL	87,500	280,000	422,000	189,000	352,000	91,000	70,000

4. For bringing about this increase in production, it has been recommended that the existing mills should increase their production by 40,000 to 50,000 tons by 1951 and at the same time 12 new units, each with an annual capacity of 8,000 tons should be established. The most important feature of these development projects is the establishment of a Newsprint Factory in the Tehri-Garhwal State in respect of which, it is understood, preliminary investigations are in progress. The Government have accepted the recommendations of the Panel and have sanctioned the necessary projects. In addition, the Government have agreed to the establishment of two more mills, one at Coorg and the other at Cooch Bihar. We may, for purposes of this report, consider that this plan of development approved by the Government will materialise by 1956 and take the proportionate increase in the production of paper during the next 5 year period as about 166,700 tons per year. In the matter of strawboards and other varieties of boards, the Panel has recommended that indigenous production should increase to 75,000 tons by 1951 and to 119,000 tons by 1956. The corresponding increase in the board production for the next five years will be 50,600 tons/year.

5. Special mention must be made here of the manufacture of chemical cotton for rayon, cellophane, plastics, lacquers, explosives and other industries. Chemical cotton is the technical term for cotton pulp, prepared chiefly from cotton linters. The Panel on 'Paper Industry' has recommended that 5 million lbs. of chemical cotton per year should be produced in the country during the next 5 year period for the development of rayon and other industries. Since the manufacture of rayon at the rate of 70 tons per day has been envisaged, it is necessary that the manufacture of chemical cotton should be undertaken simultaneously.

Assessment of personnel and pattern of employment

6. It has been envisaged that the increase in the production of paper of all varieties during the next 5 years would be about 166,700 tons and of boards 50,600 tons. On the basis of the production to personnel ratio stated in para 2 above, the total technical staff required for the development of Paper and Board Industry in the country would be as given below after allowing reduction in the staff requirements for possible expansion of the existing units.

The staff required for the production of 5 million lbs. of chemical cotton per year in two units (each of 8,350 lbs./day) may be taken as consisting of 4 senior chemists and 2 chemical engineers and an equal number of junior personnel or operators for each unit.

TABLE III

Requirements for staff for Paper, Board and Chemical Cotton Industries

Senior chemists or chemical technologists in paper manufacture	290
General mechanical and electrical engineers	264
Chemical engineers	4
Chemists or chemical technologists with specialised training in cellulose technology	8
Junior chemists or operators	298
Junior engineers or operators	268

Industrial training

7. The following industrial training facilities are likely to be available.

Concern	Candidates that could be trained	
	Chemists	Engineers
Titaghur Paper Mills	10	10
Bengal Paper Mills	8	8
India Paper Pulp Co., Ltd.	8	8
Shree Gopal Paper Mills, Ltd.	8	8
Upper India Couper Paper Mill Co.	6	6
Mysore Paper Mills Co., Ltd.	6	6
Star Paper Mills	6	6
Deccan Paper Mills Co.	6	6
Punalur Paper Mills	6	6
Orient Paper Mills (only craft paper)	6	6
Boards		
Rohtas Industries	8	8
Upper India Couper Paper Mills	2	2
Orient Paper Mills Co.	2	2
Strawboard Manufacturing Co., Saharanpur	5	5
Jeswant Strawboard Mills, Meerut	5	5
Strawboard Products, Bhopal	5	5

NOTE.—The Ministry of Industries and Supplies states as follows :

"The Paper Panel fixed the 1956 target of production at 200,000 tons for writing and printing varieties and 40,000 tons for newsprint. Against this target the present potential output of the existing units is about 106,000 tons. It is expected that as soon as normal working conditions are assumed this 106,000 tons would be available without any additional staff. Out of the balance of 94,000 tons plans are in hand for the expansion of the existing units to yield about 55,000 tons. No appreciable increase in staff would be required for this target because the existing staff of the mills concerned would be sufficient for the purpose. This leaves a balance of 39,000 tons to be made by the new units. Four more units of which two will be 10,000 tons per year capacity, one of 15,000 tons capacity and the fourth of 4,000 tons capacity, are expected to come into production by 1956. Besides the above four units, Messrs. the National Newsprint and Paper Mills Ltd. are putting up one unit of 30,000 tons per annum capacity for the manufacture of newsprint against the target figure of 40,000 tons."

The Ministry also states that :

"Normally the requirements of an average paper manufacturing unit would be—

1 Chief Chemist
1 Assistant Chemist
3 Shift Chemists
and 1 Chief Engineer
1 Assistant Engineer
3 Shift Engineers."

On the basis of the above the Ministry estimates the staff requirements for 39,000 tons of paper as—

27 Chemists (senior and junior)
and 27 Engineers (mechanical and electrical).

The facilities available in paper concerns are adequate for the training of 64 chemists and 64 engineers every year or 320 chemists and 320 engineers during the next 5 years.

8. From discussions held with principal paper concerns it has been felt that for the development of paper industry and especially of manufacture of newspringt in the country, suitably qualified India technical personnel should be trained in industrial concerns abroad. Since the training facilities available in the country in the matter of cellulose technology with particular reference to the manufacture of chemical cotton are poor it has also been suggested that some persons should be trained abroad in this field. The following indicates our requirements for the next 5 years regarding training of personnel abroad.

Paper manufacture with particular reference to the manufacture of newsprint.	Two teams, each consisting of 2 chemical technologists and 2 engineers.
Cellulose technology with special reference to the manufacture of chemical cotton, cellophone and other cellulose products.	Two chemical technologists.

D. Cement

Present position

1. The present production capacity of cement in the country is about 2.075 million tons per year distributed zone-wise as follows:

Bihar	0·598 million tons per year.
Madras	0·360 Ditto.
C.P.	0·250 Ditto.
Indian States	0·867 Ditto.
	2·075 million tons per year.

Technical staff employed

2. From a sample survey conducted in two principal concerns it has been found that the technical staff employed for the production of about 100,000 tons of cement per year consists of 15 engineers, 6 chemists and 1 geologist. Geologists in a cement factory are not engaged in the actual manufacturing operations but in prospecting for mineral raw materials. Hence, the necessity for geologists and mining engineers as also their number for a cement factory are determined not so much by the production capacity of the factory as by the raw material resources that are likely to be available for use. Consequently, the above production to personnel ratio so far as geological personnel is concerned, is governed by the raw material position and varies from one cement factory to another. It is, however, necessary that every cement factory should have well-qualified geologists and mining engineers to ensure continuous supply of raw materials to the factory.

Development and Expansion

3. A large number of cement factories in the country are contemplating expansion of production of cement by increasing the production capacity of the existing plants. At the same time, a large number of new units have been proposed to be established in various parts of the country. An overall picture of the development of cement industry in the country during the next 5 years can be had from a plan of development, approved by the government which envisages a target of 5 million tons during the next 5 year period. There is an acute shortage of cement in the country, largely due to accumulated shortages during the war period. The present production capacity can at best only relieve these accumulated shortages during the coming years but will be wholly inadequate for the ever so many civilian development plans both in the provinces and the centre, such as for instance, construction of

highways, vast multipurpose projects, house building programme etc., for the execution of which cement is an essential building material. To meet these important and urgent needs, 'sky is the limit' so far as the need for the expansion of Indian Cement Industry is concerned. The availability of mineral raw materials, fuel and power, and transport difficulties will, however, limit the expansion. With due regard to these limiting factors, we can only expect that the increase in the production of cement in the country during the next 5 years could at best only be doubled. The Government plan which envisages a target of 5 million tons or an increase in the production of cement by 2.925 million tons may be taken as the development likely to materialise during the period under consideration. It has been suggested in this plan that the location of new units should be as follows for the expansion of the cement industry.

Bengal	0.02 million tons.	
Bihar	0.20	Ditto.
Bombay	0.30	Ditto.
C.P.	0.10	Ditto.
Madras	0.25	Ditto.
U.P.	0.10	Ditto.
Orissa	0.10	Ditto.
Assam	0.10	Ditto.
States	0.60	Ditto.
Total	1·77 million tons.	

The balance of 1.15 million tons is to be made up by the expansion of the existing plants.

Assessment of personnel and pattern of employment

4. The technical staff required for cement industry falls under two distinct categories, *viz.*, general mechanical and electrical engineers and chemists, both of whom should possess adequate academic qualifications as well as experience in the industry. The chemists are usually graduates or post-graduates in chemical technology with training in the industry. Honours graduates and post-graduates in general chemistry with training in the industry would also do. On the basis of the increase in the production during the next 5 years and the production to personnel ratio outlined in previous paras, the following assessment of the requirements for personnel for the development of cement industry may be made.

Engineers	438
Chemists	175

Assuming that the Senior and junior personnel in the factory are in equal proportion, the requirement would be:—

Senior or executive engineers	219
Senior chemists or chemical technologists	88
Junior engineers or operators	219
Junior chemists or operators	87

The above excludes geologists and mining engineers that would be required for the prospecting of mineral raw materials for cement factories and no basis exists on which we can assess the requirements for this personnel. We may, however, make a tentative estimate of 15 geologists or mining engineers for the projected development.

Industrial training

5. The following industrial training facilities are likely to be available in the principal cement factories in the country.

Associated Cement Cos. of India Ltd. (6 principal concerns)	5 chemists and 5 engineers in each concern.
Rohtas Cement Co., Ltd., Dalmianagar	5 chemists and 5 engineers.
Dalmia Cement Co., Ltd., Trichinopolly	5 chemists and 5 engineers.
Andhra Cement Co., Ltd., Bezwada	3 chemists and 3 engineers.
Assam Bengal Cement Co., Ltd.	3 chemists and 3 engineers.
Mysore Iron & Steel Co., Cement Works, Bhadravati	2 chemists and 2 engineers.

The above facilities are adequate for the training of 240 chemists and 240 engineers during the next 5 year period assuming that the period of training is one year.

Training of geologists will have to be organised in establishments where facilities for such training are available especially in the Geological Survey of India, Department of Geology & Mines, Government of Mysore, General Sandur Mining, Kolar Gold Mining Co., and other mining concerns in the country.

E. Metallurgical Industries

Ferrous Metallurgy—Present position

Ferrous Metallurgy

1. The manufacture of iron and steel is concentrated chiefly in the Eastern Zone, and especially in the Provinces of Bihar and Bengal. The only other place where iron and steel are manufactured is the Mysore State, in the Southern Zone. The Eastern Zone accounts for the bulk of the production of iron and steel in the country. The present production capacity of steel is 12,64,000 tons per year. but due to various reasons, the actual production is only 900,000 tons. There are 3 principal concerns in the Eastern Zone engaged in the manufacture of pig iron and steel of which one (Ordnance Factory, Ishapore) is owned by the Government. The only concern which exists in the Southern Zone is a Mysore State enterprise and is noted for the manufacture of charcoal pig iron and electric furance steel. This concern also carries on destructive distillation of wood for charcoal, required in the production of pig iron; and the products of distillation such as methyl alcohol, wood tar, acetic acid etc. are recovered. The present installed capacity of the various concerns is as follows:—

TABLE I

Concern	Production capacity (tons/year)		
	Steel	Pig Iron	Alloy and other products
Tata Iron & Steel Co.	850,000	....	....
Steel Corporation of Bengal	350,000	150,000 (Saleable)	....
Mysore Iron & Steel Works	40,000	4,260 Do.	900 tons of C.I. pipes. 1,040 (Ferro-silicon.)
Ordnance Factory, Ishapore	24,000	....	....

2. Special types of steel such as high speed steel, tool steel, alloy steel, drill steel, stainless steel, etc. are not at present being manufactured to any extent as this special branch of metallurgical industry develops in keeping with the development of engineering and machinery manufacturing industries. Since these consuming industries have not developed on any substantial scale in the country at present, the demand for these special steels has been very small and has consequently been met by imports. It is, however, to be mentioned that ferro-silicon is being manufactured in Mysore in some quantities.

3. A large number of steel re-rolling units—over 130 big and small ones—are distributed all over the country and produce about 75,000 tons of steel products with such raw materials as scrap, billets, electric steel etc. The ostensible reason for the successful working of such a large number of mills at least of the principal ones is that these could roll special products, which are required in relatively small quantities for special purposes and which cannot be more economically produced and distributed by the bulk production units.

4. The secondary lines of ferrous metallurgy in which development has been significant are structural engineering, ship building, railway wagon building, iron and steel casting and forging and minor iron and steel products such as wire, nuts bolts, screws, hollow ware etc. These will be referred to in detail under 'Engineering Industries'.

Technical Staff Employed

5. From a close study of the production and personnel data relating to one principal concern in the Eastern Zone, it has been found that the technical staff required for the production of about 100,000 tons of iron and steel per annum is as follows :—

Chemists	20
Electrical Engineers	21
Mechanical Engineers	14
Mining Engineers	7
Metallurgical Engineers	25
Fuel Engineers	6
Safety Engineers	2
Refractory Engineers	2
Metallurgists	8
Geologists	2
Miscellaneous engineering staff, such as safety engineers, locomotive engineers, etc.	6

Development and Expansion

6. As has been stated earlier, the present production capacity of finished steel of all classes in the country is about 1.26 million tons per annum. This falls short of our present as well as future requirements which have been estimated at 2½ to 3 million tons/year.

Consequently, the Government have had a plan worked out through the Panel on 'Iron and Steel' for the development of the industry in the country. This plan, which is in the course of execution envisages both short-term and long-term measures—the former for increasing the production capacity of the existing concerns and the latter for the establishment of two new steel units. Both the measures are, however, for the next 5-year period. It as been decided that the expansion of the existing units should be as follows :—

Tata Iron & Steel Co.	150,000 tons.
Steel Corporation of Bengal	100,000 „
Ordnance Factory, Bengal	36,000 „
Mysore Iron & Steel Works	20,000 „
	306,000 „

(It is to be noted that the target of expansion mentioned above in respect of the last three concerns are those which have been worked out by the Government and considered at the recent conference on Industrial Development and differ materially from the targets proposed by the Panel. We have, for purposes of this report, considered only the targets proposed by the Government).

7. As regards the two new units proposed to be established, the Government have decided that one of these should be located in Bihar and the other in C.P. and that each of these units should have an initial capacity of 500,000 tons of steel/year and an ultimate capacity of one million tons.

The net increase in the production of steel during the next 5 years or earlier may be estimated at about 1.3 million tons/year, as a result of the development plan.

8. During our survey we have collected details of the development plans of some of the existing concerns, which are briefly as follows :

Mysore Iron & Steel Works.—Increase in the production of ferro-silicon from 1,900 tons to 4,500 tons/year ; increase in the production of electric furnace pig iron from 80 tons to 300 tons/day ; increase in the production of steel casting from 300 tons to 720 tons/year ; and manufacture of special alloy and tool steels at the rate of 600 tons year.

Tata Iron & Steel Co.—Increase in the production of saleable steel to 1.3 million tons/year; manufacture of new products such as skelp, hoops, tubes, hot and cold rolled strips, etc.

The development projects of the Mysore Iron & Steel Works outlined above relate to an all-round development of the concern and include the proposed increase by the Government in the output of steel of this concern. The projects are likely to materialise during the next 10 years. It is undertstood that the projects of the Tata Iron & Steel Co. for increasing the output of steel to 1.3 million tons are of a long-range nature and are not likely to materialise during the next 5 years, but later--perhaps in the subsequent 5-year period.

9. In the matter of special steels, the Panel has estimated that indigenous production of high speed steels, carbon tool steels, alloy steels, drill steels and stainless steels should be increased to about 8,500 tons/year to meet the requirements of Engineering and Machinery manufacturing industries. Large-scale development of these industries has been planned which could require improved qualities of steel to sustain the stress, wear and tear imposed by conditions under which machines, tool and machinery made from such materials have to operate.

10. Little development or expansion of steel re-rolling industry in the country is expected in the near future. As it is, the industry has been having many handicaps especially due to shortage of supply of steel. According to the Panel, the various products from the mills could only increase from 75,000 to 100,000 tons/year.

11. It is understood that large deposits of iron ores have been discovered somewhere in the Southern Zone and that these deposits are going to be worked out for the manufacture of iron and steel in that zone. But we do not know yet the extent of these deposits, nor at what stage the plans are for the utilisation of the ores. As far as we can foresee it is unlikely that any plan for utilisation of these newly discovered ores will materialise in the immediate future. At best such a plan can only be considered as a long-term project, which might take shape during the next 10-year period or later.

12. Certain parts of the country are very rich in respect of some strategic minerals, as for instance, rare earth minerals, manganese, chromium, beryl, etc. The National Mineral policy has laid down that all the various strategic minerals and minerals of economic importance should be conserved and utilised on a planned basis and that no mineral of importance should be exported in the raw state. In pursuance of this policy, efforts are being made to utilise the monozite sands of Travancore for the manufacture of thorium nitrate, titania and other products. This aspect is, however, more in the nature of a chemical industry than of metallurgical industry. Efforts are also being made in Sandur State to conserve good quality manganese ores and to manufacture by electric furnaces, ferro-manganese or spiegelissen and export it instead of the raw material. When these efforts succeed, in all probability during the next 5 years, an Electro-metallurgical Industry for the utilization of manganese ores will develop in the Southern Zone on a fairly large-scale. To begin with, the Sandur plan is to carry out an optimum scale of operation on the basis of 20—22,000 K.W. or 28,000 H.P. electric furnace.

Assessment of personnel

13. The technical personnel required for the development of Iron and Steel industry during the next 5 years has been assessed as given below. In this assessment, the requirements for personnel for the two new steel units which constitute the most important part of the development plans have been determined on the basis of personnel to production factors obtaining in the Tata Iron & Steel Co., Ltd., in Jamshedpur. Wherever the individual concerns have indicated the requirements for personnel for their development projects, such particulars have been included. For the rest, the assessment has been based on the technical aspects of the processes of manufacture, unit of operation etc.

TABLE II

Requirements for personnel for Iron & Steel Industry

(For the next 5 year period)

Chemists	280
Mining Engineers	100
Electrical Engineers	300
Mechanical Engineers	210
Fuel technologists or Fuel engineers	80
Refractory engineers	30
Metallurgists and Metallurgical Engineers	420
Geologists	30
Miscellaneous engineers (Safety engineers, locomotive engineers, etc.)	80
Civil Engineers	30
Chemical engineers	6
Physicists	2
Operator Engineering	200
Operator Metallurgy	100

It is not possible to make any accurate forecast of the requirements for personnel for the subsequent 5-year period, as the trends of development in many a respect are hard to assess for that period. Besides, some of the first 5-year projects are likely to be carried on to the 2nd five year period for completion. However, the following indicates the probable requirements for personnel for some of the important development projects—as for instance increasing the capacity to one million tons of each of the two new steel units, expansion of the steel production capacity to 1·3 million tons of the Tata Iron & Steel Co., increase in the SCOB's output of steel by 0·3 million tons, starting of an Iron & Steel Industry on a modest scale in the Madras Presidency utilising the iron ores recently discovered in that province etc., likely to be undertaken and completed during the latter period.

TABLE III

Additional requirements for the next 10-year period

Chemists	335
Electrical engineers	365
Mechanical engineers	285
Mining engineers	110
Metallurgical engineers	380
Fuel engineers or Fuel technologists	90
Refractory engineers or technologists	30
Civil engineers	40
Metallurgists	140
Geologists	40
Unclassified engineers (Safety engineers, loco engineers, etc.)	90
Chemical engineers	6
Physicists	2

A large number of medical personnel as many as 180 doctors are also rquired, on the basis of conditions obtaining in the Tata Iron & Steel Co. This category of personnel has, however, to be considered separately.

Industrial training

14. Industrial training facilities available for ferrous metallurgy are confined to 5 principal concerns which are engaged in this field at present. The following indicates the facilities likely to be available in each concern.

Concern	Field of Training	No. of persons that could be trained	
Mysore Iron & Steel Co.	Iron and steel met allurgy including electro-metallurgy of steel and alloys.	Elect. engineers	4
		Metallurgists	4
		Mech. engineers	4
,,	Wood distillation and metallurgical chemistry.	Chemists	4
		Chemical engineers	2
Tata Iron & Steel Co.	Iron & Steel metallurgy including electro-metallurgy of steel and alloys.	Metallurgical engineers	8
		Mech. engineers	8
		Elect. engineers	8
		Metallurgists	8
		Refractory engineers	4
		Fuel an furnace technologists	4
Steel Corporation of Bengal	Manufacture of steel and steel products	Metallurgists	6
		Mech. engineers	4
		Chemists	2
Indian Iron & Steel Co.	Manufacture of pig iron and steel and steel products.	Metallurgists	6
		Mech. engineers	6
		Elect. engineers	4
		Chemists	2
		Refractory engineers	4
		Fuel and furnace technologists	4
Ordnance Factory, Ishapore	Manufacture of steel	Mech. engineers	4
		Elect. engineers	2
		Metallurgists	4
		Chemists	2

15. Special mention must be made here of the research training facilities available, especially at the Tata Iron & Steel Co., Jamshedpur. In the field of metallurgical research, the Tata Iron & Steel Co. have created their own research facilities independent of other bodies and have established at Jamshedpur a very well equipped laboratory staffed with highly qualified technical personnel and with the best of equipment. Separate pilot plants are also being maintained at the laboratory for large-scale research. Specific researches are conducted in this laboratory for improvement and development of products in the field of metallurgy, fuels, refractories and related chemical problems. At present there is no other research laboratory in India for metallurgical researches whose scope and standard can equal that of the Tata Research Laboratory. It is understood that the concern is prepared to train a limited number of personnel from outside. Highly specialised training in metallurgy can be arranged for 2 to 5 persons in different branches. The following indicates in detail the research training facilities available:

Subject	No. of persons that could be trained in metallurgical research
Metallurgy	8
Fuels	6
Refractories	2
Metallurgical Chemistry	8
Ferro alloy tools	2
Special steels	2
Armour plates	2
Spectroscopy applied to metallurgy	2
Process problems and production	2

Training abroad

16. In the matter of training of Indian personnel abroad for the development of iron & steel metallurgy, the following indicates our requirements for the next 5 year period:

Subject	No. of men to be trained
General ferrous metallurgy including manufacture of electric furnace steel etc.	8
Fuel and furnace technology	4
Alloy steels and special steels armour plates and other armament steel for defence purposes.	5
Manufacture of soft iron for magnets, electrical sheet steel, spring steels, etc.	4
Metallography	4
Foundry	6
Heat treatment of metal and alloys	5
Mill experts (for skelp mill, strip mill, tube mill, etc.)	4

Non-ferrous Metallurgy

17. Non-ferrous Metal Industry is closely linked up and its development dependent on the progress of Mineral Industry. No significant progress has been made in Indian Mineral Industry and consequently, non-ferrous metal industry in the country has remained in an undeveloped or partially developed state. India possesses considerable deposits of bauxite, magnesite, manganese and titanium ores, but so far this mineral wealth has been exploited only on a small scale. Despite the large demand for aluminium, for the production of which there is no lack of mineral raw material, India produces only about 6,000 tons of the metal. Manganese and titanium ores are not processed in the country, but are only exported in the raw state. While other countries have had to tap sea-water for magnesium, we have made no use of our magnesite deposits—which are perhaps the richest in the world, except for minor refractory purposes. It is only recently that we have come to realise the importance of our beryl deposits, which we have been exporting all these years for the manufacture of beryllium in other countries.

Very few workable ore deposits of the important industrial metals like copper, lead, zinc, tin, nickel, tungsten etc. have been discovered, so far in the country. This does not necessarily indicate that there are no ore deposits of these metals.

18. The present position of non-ferrous metal industries in I ndia may be clasified into the following groups :

(*a*) Primary production or production of virgin metals from Indian ore deposits;

(*b*) Secondary production or reclamation of metals and alloys from non-ferrous scap;

(*c*) Processing of primary or secondary metals and alloys into semi-finished materials like sheets, rods, pipes, tubes, wires etc.; and

(*d*) Fabricating and casting industries making finished products out of sheets, wires, etc. and castings out of primary or secondary metals and alloys.

The only primary metals produced in India are copper, aluminium, antimony and small quantities of lead. The present production is as follows:

Copper	6,000 tons.
Aluminium	7,500 „
Antimony	250 „
Lead	100 „

Copper ores occur chiefly in Ghatsila, in Bihar and the Copper Industry is located in that place. Only one concern is engaged in that field. Aluminium is being manufactured both in West Bengal and in Travancore and two concerns are engaged in the line. Antimony is being produced in Bombay by one firm with ores brought from the Chitral State.

23. The Panel on Non-ferrous Metal Industries has suggested that the production of copper in the country should be doubled from 6000 to 12000 tons. Such increase in poroduction will, of course, depend either on the exploitation of the other belts of occurrence of the ore, which are less known at present or on the possibility of importing concentrated ores from Burma and other places for smelting in the country.

24. Export of beryl has been banned by the Government with a view to conserving the strategic mineral and to manufacturing beryllium and its alloys. Research investigations carried out in the country have, it is understood, been successful and large-scale manufacture of the products could be taken up shortly.

25. In the matter of processing and fabrication lines of non-ferrous metal industry, the development will not be insignificant in that most of the leading concerns have plans for installing modern plant and equipment, and it is believed that during the next 5 years India will be able to meet all her requirements of semi-manufacturers such as strips, foil, rods, tubes, shapes, wires, cables etc. Of special importance are the plans of two concerns the one for the manufacture of bare and insulated copper wires and cables of all sizes for electrical industry and the other for the manufacture of aluminium conductors and electrical transmission lines.

Assessment of Personnel required

26. There is no reliable basis supported by factual data on which the requirements for technical personnel may be determined for the development of Non-ferrous Metal Industry in the country during the next 5 years. Consequently, we could at best only indicate as given below, what we believe the possible requirements in consideration of the nature & scope of development of the industry.

TABLE IV

Metallurgists & metallurgical engineers	75
Electrical engineers with specialised training in electro-thermics	5
General mechanical & electrical engineers	30
Fuel engineers or technologists	10
General & Inorganic Chemists	10
Operators—metallurgical	50
Operators—engineering	50

It is to be noted that the technical personnel required for the development of Aluminium Industry has not been included in the above, as this has already been considered under 'Electro-Chemical Industry'.

Industrial training

27. The following industrial training facilities are likely to be available in the non-ferrous metallurgical industrial concerns in the country.

Concern.	Field of training.	No. of persons who could be trained.
The Indian Copper Corporation, Ghatsila	Copper metallurgy	44 metallurgists 2 chemists.
The Indian Standard Metal Co., Bombay	Non-ferrours processing & metallurgy	2 metallurgists
Kamani Metal Refinery & Metal Industries Bombay.	Non-ferrous processing & Metallurgy	3 metallurgists.
Binani Metal Works, Calcutta	Secondary production and processing	2 metallurgists.
Bengal Ingot Co. Ltd., Calcutta	Secondary production	1 metallurgist
Jayant Metal Refineries, Bombay	Non-ferrous processing	1 metallurgist.
National Insulated Cable Co. of India, Calcutta.	Non-ferrous fabrication industry with special reference to manufacture of bare & insulated copper, wire & cables for electrical industry.	2 metallurgists. 2 engineers.
India Rolling Mills Ltd., Calcutta	Non-ferrous processing	2 metallurgists.
Waldies Industries Ltd., Calcutta.	Lead metallurgy.	1 metallurgist.

19. Secondary production or scrap refining is a recent development in the country and several firms are now engaged in the refining of white and yellow metals. Processing of primary or secondary metals or the semi-manufacturing industry received considerable impetus during the war and in spite of many handicaps, it is stated, India was able to meet most the defence requirements in respect of sheets, rods, wires etc. of aluminium, copper and brass.

Fabricating Industries are limited only to the manufacture of aluminium and brass utensils. Small non-ferrous foundries are scattered all over the country but only a few of them, it is understood, prodnce articles of industrial value.

20. The following table indicates in outline the salient features of the present position of Non-ferrous Industry in the country.

Line of manufacture	No. of principal concerns engaged	Production
Primary Production—		
Copper	1	6,000 tons
Aluminium	2	7,500 „
Antimony	1	250 „
Secondary production—		
Semi-manufacturing Fabrication	18	37,750 „ (For 15 concerns.)

It is to be noted that several concerns are engaged in all the three lines of activity—secondary production or scrap refining, processing and fabrication. Western and Eastern Zones have between themselves the bulk of the Non-ferrous Metal Industry of the country. One concern in the Western Zone specialises in the manufacture of phosphorous alloys—phosphor bronze, phosphor copper, etc. antifriction metals, high tensile brass and other similar products.

21. A good number of technical personnel—metallurgists, chemists and mechanical engineers are understood to be employed in the industry at present, but we have been unable to obtain full details in this respect from the concerns.

Development and Expansion

22. It is to be admitted that the trends of development of non-ferrous metal industry in the country during the next 5 or 10 years period are hard to assess at this stage. For one thing, the primary production of virgin metals of importance such as lead, tin, nickle, zinc etc. depends entirely on our ability to discover the necessary ore deposits through intensive mineral prospecting ; and no one can at this stage predict the outcome of such prospecting. For another, the present state of development of the industry, whatever it be, is due to the impetus given to it during the war, when scrap refining and manufacture of alloys from Imported raw materials and other aspects of the industry enjoyed a position of importance, which may not be retained in the coming years unless the industry is 'artificially' protected. There is, however, no doubt that in certain respects which are no less important, the industry can and will develop during the next 5 years. The chief of these is the utilization of the available mineral resources bauxite, magnesite, manganese and beryl for larger production of metals and alloys. The present production of aluminium is only 7500 tons while consumption during the next 5 years is estimated at about 20,000 tons. The necessary raw materials and power being available, the aluminium industry has scope for a ten-fold increase. As a matter of fact, plans are underway for the development of aluminium industry in the country and we have already referred to them under 'Eletro-chemical Industries'. Closely associated with aluminium industry is the light metal alloy industry, which develops in keeping with the development of aircraft, automobile, railway and shipbuilding industries. As these consumer industries have considerable scope of development in the country, it may be expected that the light metal alloy industry also will develop. Magnesium is an important constituent of light metal alloys and may be produced from Indian magesite either by the thermal or the electro-chemical processes.

Mineral	*Quantity in tons.*
Feldspar	338
Flourspar	1,230
Fuller's earth	11,075
Galena	18·5
Garnet	23
Gold	188,200 ozs.
Graphite	927
Gypsum	83,706
Ilmenite	100,794
Iron ore	2·4 million
Kyanite, Sillimanite, Quartzite, etc.	29,186
Magnesite	41,936
Manganese ore	370,980
Mica	3,612
Monazite	2,016
Ochres	12,183
Petroleum	97·453 million gallons,
Rutile	1,646
Salt	1·865 million
Salt petre	30,807
Silver	14,240 ozs.
Steatite	21,392
Wolfram	30
Zircon	755

The above figures are for the whole of undivided India. The partition of the country has not affected the mineral wealth of the Indian Union to any appreciable extent except in the case of petroleum, rock salt, antimony and salt petre. The chief minerals of economic importance accurring in the country in considerable quantities are coal, iron ore, manganese,chromite, rare earths and monozite sands, magnesite and bauxite. India holds a very important place in the mineral trade of the world in respect of manganese, chromite, magnesite, mica and rare earths, consisting of rutile, ilminite, throium etc. Beryl and important source of beryllium also occurs in the country in some quantities. It is to be noted that India is very poor in respect of non-ferrous mineral resources such as lead, tin, zinc etc.

Development and Expansion

3. It is rather difficult to present a correct quantitative picture of the future development of Mineral Industry in the country. This is so because any development likely to take place is intimately bound up with the outcome of mineral survey and prospecting, employing geophsical and other latest methods and such a survey is yet to be organised on an extensive scale. The issue is also largely bound up with the development of Chemical, Metallurgical and other industries, which depend on mineral resources. Qualitatively, however, certain trends are well defined. So far, India has only been exporting her mineral wealth in the raw state. This will cease and instead, minerals of economic importance will be conserved for utilization in the country and the rest fully processed before export, as the National Mineral Policy, formulated by the Mineral Conference, sometime ago makes it quite clear. Uneconomic and unscientific methods of mining now largely in practice will be replaced by modern scientific methods so that the mineral wealth is not exploited in any haphazard manner. Such haphazard working of minerals which has already told on the country's wealth is particularly noticed in the case of coal. Intensive mining of all the impo tant minerals required for the industrial development will proceed. As regard the last aspect, we have in this section dealt in detail with the lines and scope of development of Chmical, Metallurgical and other Industries in the country during the next 5 and subsequent years and have also brought out by implication the extent of the requirements for mineral raw materials for the development of these industries. For the success of these industrial projects, development of Mineral

Training abroad

28. In the matter of training of Indian technical personnel abroad, we have received little or no useful suggestions from the Industry. However, we feel that there is considerable scope for such training, especially in such fields as for instance, manufacture of magnesium, light metal alloys, beryllium and its alloys etc. in which we have yet to make a beginning in this country. For the next 5 year period our requirements would be as follows :—

Field of training	No. of persons to be trained abroad
General non-ferrous metallurgy Primary production, scrap refining processing and fabrication	5 metallurgists. 5 metallurgical engineers.
Manufacture of light metal alloys	2 teams, each consisting of 2 metallurgists, and one metallurgical engineer.
Manufacture of beryllium and its alloys	1 team consisting of 1 metallurgist and 1 chemist
Manufacture of magnesium—	
(a) Electro-chemcial process	1 team consisting of 2 electro-chemists 1 electrical engineer, and 1 metallurgist.
(b) Thermal or Pidgeon process	1 team consisting of 2 metallurgists, and 1 electrical engineer.
Manufacture of electrical resistance wires and heating elements such as Nichrome, Tantiron etc.	2 metallurgists.
Powder Metallurgy	2 metallurgists.

F. Mining Industry.

1. Indian Mines are at present in various stages of development corresponding to the type of operations employed which range from crude surface mining to scientific deep mining. Mining of mica and gold illustrate the two extreme stages and manganese, chromite, coal, magnesite bauxite etc., the intermediate ones. A large number of concerns big and small are engaged in the industry. Governments too—both Central and certain Provincial and States—are carrying on mining operations, the Central Government particularly for coal. We have received little useful information from the industry in reply to our questionnaire.

2. The following statement indicates the production of minerals in India during 1944.

Table I

Production of Minerals in India during 1944

Mineral	*Quantity in tons*	
Coal	26	million
Antimony	962	million
Apatite	228	million
Aquamarine	5	tolas
Asbestos	583	
Barytes	15,300	
Bauxite	12,135	
Bentonite	10	
Beryl	500	
Building Materials	14	million
Calcite	1,410	
Chromite	39,555	
China Clay	89,220	
Copper	326,000	
Corundrum	343	
Diamonds	1,837	carats

In the matter of training of Indian personnel abroad, we have received no suggestions at all from the industry. The following, however, indicates our assessment of our requirements for the next 5 years.

Modern methods of mining including deep-mining, beneficiation of ores and minerals etc.	10
Geophysical and other methods of mineral prospecting	8

Fuel, Power and carbonisation Industries

1. Coal is by far the most important industrial fuel in India at present. About 30 million tons of all varieties of coal are raised annually in the country of which 10 million tons are carbonised and the rest largely consumed by Industry and Railways almost in equal proportion. Although India ranks as the second largest producer of coal in the Commonwealth, the per capital output of work based on power is only one twentieth of that of European countries. This paradox throws into bold relief the chaotic state of Fuel and Power Industry in the country caused chiefly by wasteful methods of utilisation of the fuel resources. Carbonisation Industry which is closely associated with the Fuel Industry further illustrates the point. The potential output of tar is about 80—90,000 tons while 5 tons of tar ought to be obtained generally for every 200 tons of coal carbonised. For 10 million tons of coal stated to be carbonised annually at present, the output of tar should be about 250,000 tons. The obvious inference is that less than 50 per cent of the coal carbonised is according to right scientific methods in efficient coking plants and the rest is subjected to wasteful methods of treatment especially in the matter of by-product recovery. We have had occasion to refer in detail under ' Chemical Industry ' to coal-tar distillation and have stressed the poor state of development of this aspect of the Industry.

2. In the matter of liquid fuels India's resources of mineral oils are very poor indeed especially since the partition of the country. The only petroleum fields now in the Indian Union are in Assam capable of producing about 82·3 million gallons of petroleum per year.

3. As regards power, the installed capacity of the generating plants during 1944 is stated to be as follows :

(a) Steam Plant	682,936 K. W.
(b) Hydro-plant	479,019 K. W.
(c) Oil Plant	118,029 K. W.

and the corresponding million K. W. hours of energy generated during the same year were :—

(a) 1632·536 million K. W. H.
(b) 2053·258 million K. W. H.
(c) 155·518 million K. W. H.

There has since been considerable increase in the installed capacity of hydro-electricity as a result of new hydro-electric stations--Papanasam, Jog falls project etc.—that have been set up. Hydro-electric generation, transmission, and distribution are State enterprises in the provinces and Indian States and we have covered this aspect in detail under ' Government and Government-sponsored Departments '. The field of thermal-electricity as an industry is at present exploited mostly by private enterprise and a large number of concerns are engaged in generation, transmission and distribution. We shall refer to this aspect in detail under ' Engineering Industries '.

Development and Expansion

4. We have not received in reply to our questionnaire any useful information regarding the future development of Fuel and Carbonisation Industries in the country during the next 5 or 10 year periods. But against the general background of the present state of these industries described in the preceding paras. it may be possible to present a qualitative picture of the developments likely to take place. According to the latest pre-war survey, the total coal reserves of India are estimated to be about 65,000 million tons of which about 22,000 million tons are considered to be workable at present. The good

Industry in the country on right scientific lines would be called for. As a first step towards the realisation of all these objectives, the Government of India have recently set up a Bureau of Mines to advise the Government on the conservation and planned utilization of the mineral resources of the country and for the development of the Mineral Industry.

Requirements for Staff

4. In the absence of any factual data no correct estimates can be given of the requirements for scientific and technical personnel for the development of Mineral Industry in the country during the next five year period. There is also no other means, direct or indirect, of arriving at these estimates. Consequently, we can, at best, only give at this stage certain tentative figures which may be taken as the ceiling requirements.

TABLE II

Requirements for Scientific and Technical Staff for the Mining Industry

Category	No.
Mining Engineers—	
Senior or Executive	200
Junior or Operators	200
Geologists—	
Senior or Executive	50
Junior or Fieldmen	200
Mechanical Engineers—	
Senior or Executive	50
Junior or Operators	100
Electrical Engineers—	
Senior or Executive	50
Junior or Operators	100
General Inorganic Chemists (For Analytical work)—	
Senior or Executive	50
Junior or Assistants	50

It is to be noted that the geologists mentioned above are exclusively for the industry and not for the Geological Survey and other official, non-commercial organizations.

Industrial training and training abroad

5. A large number of concerns, big and small, are engaged in the mining of various minerals in the country but we have not received in reply to our questionnaire any details of training facilities available in each individual concern. We, however, believe that it should be possible to arrange for the training of a certain number of candidates every year in some of the larger concerns—especially in those engaged in the mining of coal, gold, manganese, chromium, petroleum, etc. The following indicates the important mining concerns and the training facilities that obtain in them.

Concern	No. of men who might be trained at a time.
Government Collieries and Private Coal Mining Concerns	20
Kolar Gold Mining Co.	8
General Sandur Mining Co.	4
C. P. Manganese Ore Co.	4
Assam Oil Co.	4
Indian Copper Corporation	4
Other important mining concerns	6

10 The Government of India have decided recently to produce liquid fuels from coal by the hydrogenation processand heave, for this purpose, appointed an American firm of Engineers, *viz.*, Messrs. Koppers, to advise thm on the project. The manufacture of liquid fuels from coal will represent a most important development in Indian Fuel Industry. No details of the size of the project are available at this stage, but it may be assumed that about one million tons of oil would be produced every year, requiring about 7 million tons of coal. Incidentally, it may be stated that the production of liquid fuels from coal will create an important economical outlet for low-grade coals, large quantities of which are available in the country.

Requirements for Staff

11. The following represents the approximate requirements for technical personnel for the development of Fuel Industry in the country during the next 5 or 10 year periods, comprising coking and carbonisation, coal-tar distillation and liquid fuels from coal.

Senior or Executive Category		Junior or Operator Category	
Fuel Technologists	50	Chemists	100
Organic Chemists	50	Engineers	100
Physical Chemists	25		
Chemical Engineers	20		
Mechanical Engineers	25		
Electrical Engineers	25		

Industrial Training and training abroad

12. There is a considerable number of modern coking plants and a few tar distillation plants in the country which can provide facilities for the training of about 10 Fuel Technologists and 5 Chemists at a time in their works in carbonisation and coal-tar distillation aspects.

As regards production of liquid fuels from coal, it is necessary to arrange for training abroad for one or two batches, each batch consisting of 2 chemists, 1 chemical engineer and 1 mechanical engineer.

G. Textile Industry

1. The textile industry in the country may be classified into six distinct groups, namely, cotton textile industry ; silk and rayon industry ; woollen textile industry ; Hosiery industry ; jute industry and subsidiary industries such as ginning mills, woollen presses etc.

Cotton Textiles

2. It is one of the principal well established industries. In the extent of its development and in the quality of its products the industry has reached a stage which may be regarded as fairly satisfactory. It has attracted the largest capital investment and is at the same time the single largest employer of industrial labour, both skilled and unskilled.

3. The industry as it exists consists of two well defined sections ; (*a*) large mechanised mills producing yarn or cloth or both, and (*b*) numerous small handlooms to produce cloth using yarns supplied from mechanised mills. In this report we shall confine ourselves only to mechanised mills.

4. There are 421 mills, the chief textile producing centres being in the Western and the Southern zones. The industry supports many subsidiary or auxiliary industries such as healds and reeds industry, pickle industry, shuttle and bobbin industry and starch manufacturing industry. A large amount of chemicals such as caustic soda, magnesium chloride, dyes, starch etc., are consumed by the industry. On account of the diverse nature of the activities technical personnel of various categories are employed in this industry.

quality coals, however, do not exceed 5,000 million tons but even all of this coal is not suitable for metallurgical purposes, that is to say, they are not all coking coals. The known reserves of coking coal is only about 1,400 million tons. Every year 13 million tons of metallurgical coal are raised of which only about 4 million tons are being used for metallurgical purposes. The rest are being used for purposes which do not require coking coals. This is a colossal waste and the practice will have to discontinue. The coal Mining Committee of 1937 estimated the life of the reserves of Indian coals are follows :—

(a) All good quality coals	120 years
(b) Coking coal of good quality	about 62 years.
(c) Known coking coal of good quality	about 100 years.

It will be seen that the position of coking coal reserves of India is very poor, especially in view of the fact that very large reserves of iron ore of high grade are available in the country. Within 150 miles of the coal fields alone, the iron ore reserves exceed 300 million tons. It is obvious, therefore, that the position is similar to that of South Africa where the life of coking coal reserves is estimated to about 40 years. At the present rate of output and consumption and at the present rate of waste in mining, the resources of the country can hardly last for more than 50 years unless more efficient utilisation and conservation of coking coals are practised. The first objective of a balanced development plan for Fuel Industry will necessarily have to be the conservation of coking coals and their utilisation chiefly for metallurgical purposes, and utilisation of non-coking coals for other purposes by suitable blending and other treatments.

5. Next in importance to coking coals are all grades of coal of high volatile and of non-metallurgical type. These coals apart from steam generation have very special uses such as carbonisation, by-products recovery, hydrogenation or synthetic production of oils, gas manufacture, chemical industry and so on. The Coal-tar Industry sadly neglected in the past has a great future in India, but to-day it is a necessity for the development of dyes, pharmaceuticals, plastics, insecticides, explosives and numerous other industries. We have under ' Chemical Industries ' referred to the present undeveloped state of these industries and especially of Carbonisation Industry. The future development in Fuel Industry in this respect would depend on efficient methods of carbonisation of coking and high volatile coals and full by-product recovery.

6. Another source of waste of coal is during the mining operations. During mining, about a third of the coal produced is small or ' slack ' coal and as such they have no market in India. Utilisation of this coal with the help of modern scientific and technical methods of combustion and briquetting would reduce this waste. Many of the so-called inferior grades of coal of which India possesses large and fairly unlimited reserves are also not workable at present but can be upgraded and efficiently utilised.

7. In Assam large deposits of good coking coals are available but these are at present unexploitable in view of their high sulphur content. Desulphurisation by various processes will, however, render them a very valuable source of coal for future use.

8. It is obvious that, for the development of Fuel Industries outlined above, scientific research on a comprehensive scale on Indian coals is an essential pre-requisite. The establishment of a Fuel Research Institute at Dhanbad under the auspices of the Council of Scientific and Industrial Research is a right step in this direction and it is to be hoped that, before long, this institute will help to develop Indian Fuel Industries along scientific lines. We have elsewhere in this report described in detail the organisation and functions of the Fuel Research Institute of India.

9. In the matter of liquid fuels, India's Mineral Oil resources as has been stated earlier are very poor. It has been estimated that our present requirements for petrol is about 150 million gallons per year of which only a small part is met from the Indian Oil fields. Power alcohol produced from molasses—a by-product of the Sugar Industry—is a valuable alternate source of liquid fuel. A mixture of 20 per cent Power alcohol and 80 per cent petrol relieves to a great extent the shortage of petrol as an internal combustion engine fuel. With a view to minimising the use of petrol as well as to encouraging an important indigenous industry, it has been contemplated to produce about 20 million gallons of power alcohol from the by-product molasses. We have referred to this aspect in detail under ' Sugar and Fermentation Industries '.

Present Position

5. The position of the textile industry in the country is well established and as adequate statistical data is readily available, emphasis was only laid on carrying out a sample survey so as to draw inferences in respect of man power requirements. The analytical summary of completed questionnaires returned by the industry is given in Appendix——————showing their principal lines of manufacture, value and quantity of the production, technical staff employed and their development plans etc.

6. To summarise the position :

TABLE I

Zone	Yarn in million lbs.	Cloth in million yards	Staff employed		
Western	23·8 (9 concerns).	399·4 (24 concerns).	Chemists	17	24concerns.
			Engineers	70	
			Spinning, Weaving and carding experts.	82	
			Dyeing and Bleaching experts.	20	
Northern	30·8 (7 concerns).	57·1 (3 concerns).	Chemists	26	20 concerns.
			Mech. Engr.	48	
			Elect. Engr.	15	
			Tech. Advisors	23	
			Medical	5	
			Statistics	1	
Eastern	..	..	Engineers	7	1 concern.
			Textile Technologists	9	
Southern	71·0 (3 concerns)	11·000 (1 concern).	Chemists	4	4 concerns.
			Engineers	62	
			Textile Technologists	81	

7. The present production of cotton textiles as computed by the Ministry of Industry and Supply is as follows :—

Zone.	No. of Spindles	Cloth production in million yards	Yarn production in thousand lbs.
Bombay	5,941,164	3,313	699,742
C. P.	374,030	120	67,965
East Punjab	147,381	140	40,169
U. P.	773,288	340	147,385
Rajputana	519,222	339	113,396
Bihar	25,040	12	3,097
West Bengal	388,246	174	48,962
Orissa	..	..	..
Assam	..	..	..
South India	1,955,538	299	294,022

Technical Staff Employed

8. It has not been possible to ascertain the total technical staff employed in the textile industry. From information available it appears, however, that the industry employs the following types of personnel :—

(a) Electrical and/or mechanical engineers.

(b) Textile technologists including foreman type of personnel or trained supervisers, weaving masters, dyeing masters and printing masters.

(c) Chemists to undertake routine testing of materials, for bleaching, dyeing and sizing.

For purposes of computing personnel to production ratio for this industry three major groups of mills in one zone have been studied closely. It appears that for the production of 100 million pounds of yarn per year 100 textile technologists and 76 engineers are required. (This includes foremen type of personnel or trained supervisors etc). For spinning and processing of 50 million yards of cloth of medium to fine quality and finish the requirements for personnel are 38 textile technologists, 23 engineers and 22 textile or tinctorial chemists.

Development and Expansion

9. Instead of considering in detail the development projects of individual mills, we feel, it is better to take into account the over-all development of the textile industry of the country. A post-war development plan was drawn up in 1945 and has been approved by the Government of India and is now being implemented. According to this plan the total number of spindles in the country will be increased to 4.6 million and the yarn and cloth production to 2041 million pounds and 6576 million yards respectively. This means an increase of 1840 million yards of cloth and 472 million pounds of yarn over and above the present production. The suggested increases in number of spindles in various areas and the target capacities would be clear from the following table :—

TABLE II

Zone.	No. of spindles	Target Capacity: Cloth production in million yards	Target Capacity: Yarn productio in thousand lbs.
Bombay	6,340,164	3,561	949,742
C. P.	550,030	228	91,165
East Punjab	2,470,381	349	92,969
U. P.	1,062,288	521	186,985
Rajputana	787,222	530	159,496
Bihar	238,040	161	38,697
West Bengal	618,770	345	92,162
Orissa	144,000	103	25,000
Assam	100,000	76	19,200
South India	2,574,538	702	385,622

Pattern of employment and Assessment of requirement for personnel

10. As mentioned already the scientific and technical personnel required in the textile industry fall under three categories *viz.*, textile technologists, textile engineers or a general mechanical/electrical engineers with experience in textile engineering, and tinctorial chemists or chemical technologists with experience in bleaching printing, dyeing and finishing of fabrics. Yarn spinning requires only the first two types, whereas cloth weaving and finishing requires all the three. The number of categories of personnel in a textile mill, therefore, varies according to the line of manufacture of the mill. The number of chemical personnel in a weaving establishment also depends on the quality and finish of products of manufacture.

11. For the proposed increase in yarn production mentioned above we estimate that the requirements for technical personnel during the next five years would be :

Textile technologists	**425**
Engineers	**323**

We cannot say how much of the yarn produced will be utilized in the handlooms for producing coarse mill cloth and cloth of fine quality and finish. We have assumed that out of the target fixed for cloth, 50 per cent will be coarse hand-loom or power loom cloth and the rest of medium to fine quality and finish cloth. The requirement for personnel for the production 920 million of the latter variety of cloth is estimated to be :—

Textile technologists	**700**
Engineers	**423**
Textile chemists or tinctorial chemists	**405**

12. Combining the personnel required for yarn and yarn spinning, cloth weaving and finishing we arrive at the following number and types of technical personnel required for the development of textile industry in the country, after making allowances for reduction in staff due to possible expansion of the existing units.

TABLE III

Senior or executive class :	
Textile technologists	450
Engineers	300
Textile Chemists	160
Junior or operator class—	
Textile technologists	563
Engineers	373
and textile chemists	203

Industrial Training

13. We shall first consider the industrial training of the senior or executive class of personnel. Assuming that the demand for men will be evenly spread over the period of five years we will need every year 110 textile technologists, 75 engineers and 40 chemists (Senior or executive type). In the course of our survey, we have come to understand that the majority of textile mills in the country would be willing to provide industrial training facilities in textile technology and textile engineering. Since the number of concerns is large we have not been able to obtain information from each individual concern as to how many trainees it is prepared to train. We have ascertained from four leading mills in one zone, which may be considered as representative of the whole industry, that each large group of mills could train at least four textile technologists and two engineers and two chemists.

If we select about 25 to 30 large groups of mills which have the requisite facilities it would be possible to make adequate arrangements for the training of required number of textile technologists, engineers and chemists. The training of textile chemists, however, would naturally have to be confined to a few large firms which are specializing in spinning, weaving and finishing of fine cloth.

As regards the junior or operator class of personnel we feel that no comprehensive training need be organized as this class of personnel is usually appointed by the industry as apprentices and trainees in the mills.

Training abroad

14. We have discussed with leading industrialists in the country the question of arranging foreign training of personnel for the textile industry. The majority view seems to be that there is no need for such training as the industry is sufficiently advanced and that the facilities available are adequate for the training of all types of personnel required. Some industrialists are, however, of the opinion that the industry would stand to gain if a few selected men from the industry were sent abroad to study the latest advances made in this field.

15. The number of persons that should be trained abroad has not been definitely stated. But from our discussion with the leading industrialists we have come to the conclusion that during the next 5 years we should send abroad for training the following :—

10 Textile Technologists

10 Textile Engineers

10 Textile Chemists.

The trainees should be selected from the industry and period of training should be decided in individual cases and should range from 6 months to 2 years. The textile Engineers should specialise in the machinery of Textile Industry.

Silk Industry

16. The sericulture industry in India is an important national asset. It consists of two well defined sections *viz.*, (*a*) one concerned with the production of cocoons, and (*b*) the other concerned with the production of raw silk, including the utilization of by-products. The first stage of this industry is essentially a cottage industry subsidiary to agriculture. The second stage, however, is a factory industry stage wherein the cocoon out-put of a number of areas is processed. It is at this stage that the industry requires technical manpower trained in reeling, weaving and finishing of silk fabrics.

17. The most important silk producing zones are Mysore, Bengal, Madras and Jammu and Kashmir. The Industrial Panel on silk has estimated that during the war years the area under mulberry cultivation in 1945-46 was 1,12,632 acres and the pre-war production of silk has been estimated at $1\frac{1}{4}$ million pounds. During war years production increased considerably and was in the neighbourhood of 3 million. pounds.

18. The indigenous industry is fairly well established in the producing areas. One aspect of this industry, namely, reeling, merits special mention here. Till lately the bulk of reeling used to be done by the most primitive methods with the result that the best qualities of the filaments were lost in the process. Filature reeling was introduced in the field of sericulture areas during the war years resulting in a general betterment of this industry.

19. The development programme recommended by the Panel is for the consolidation of the advantageous position acquired by this industry during war-time and its further improvement. No large scale increased activity in spinning and weaving is contemplated during the next five years. There is therefore no chance of an abnormal demand for trained personnel for this industry. The improvements which have to be effected related to mulberry cultivation, adequate supply of disease free seeds, control of silk work diseases, improvement of reeling, development of spun silk industry and fuller utilization of by-products. To implement these recommendations trained hands will be needed to staff the research institutes which have been proposed by the Panel and requirements for personnel for this purpose are discussed elsewhere in this report.

Rayon Industry

20. Considering the very important role that the rayon industry is bound to play in the national economy of the country we are of opinion that this industry has not received the attention it merits. Perhaps this is due to the highly technical nature of the industry. The absence of a well established rayon industry is costing us at least Rs. 12 crores every year in foreign currency. This figure has been arrived at by putting together the cost of rayon annually imported from abroad, whether in the form of fibre and the price we have to pay for the imports of long and medium staple cotton which could be substituted by our home manufactured staple fibre, if rayon industry is established in the country. To this is to be added money spent in getting imported transparent paper, bottle caps, artificial straw and numerous other commodities the manufacture of which is ancilliary to the rayon industry. The demand for rayon and rayon associate articles is on the increase.

21. A number of concerns have been set up mostly in the Western Zone which carry out manufacture of fabrics from imported rayon. Their number is 38 in the Western Zone and they employ 4209 looms. Three concerns are located in Amritsar having total number of 300 looms and there are about 5 other concerns which are partially suitable for weaving rayon goods. It is worthy of note that notwithstanding the considerable capital investment required for an economic unit for the manufacture of rayon and the complex nature of the industry, a beginning has been made and three Indian Companies have been registered recently. These are (1) The Travancore Rayons Ltd. (2) The National Rayon Corporation Ltd., Bombay. (3) The Sirsilk Ltd., Hyderabad. It is understood that the Govt. of Mysore is also considering the establishment of a factory near the Krishna Raja Sagar. All these firms are understood to have placed orders for machinery. The Rayon Panel set up by the Government of India have recommended that rayon factories capable of producing an aggregate of at least 70 tons per day should be set up in the country, distributed in the various regions. The minimum economic unit, according to the Panel, is one for 10 tons per day. In the light of these recommendations it my be presumed that during the next five year period these companies and others also may start manufacture of rayon.

22. The manufacture of rayon entails on the one hand production of pulp and its treatment, and on the other spinning operations. One of the concerns registered recently will use imported pulp to begin with, and later will start producing pulp from indigenous materials, specially, Ee ta Bamboo, cotton linters etc. Progress may be rather slow for the reason that there is hardly an Indian Chemist or an engineer who has had experience in this industry or for that matter worked in a rayon factory abroad and has picked up the " know how " of the various technical processes and operations. The lack of technical personnel has considerably hindered the progress of the establishment of rayon industry in the country. We cannot depend on our own resources to develop the necessary knowledge and skill for the establishment of the industry and in the initial stages we have to take help from abroad by employing foreign technical experts. All the proposed concerns have adopted this course to meet the present urgent situation. The real solution of problem, however, is to train our own national.

23. Experts have advised the Rayon Panel that the staff required for a Rayon Factory consists of :—

One Chief Engineer, one Chief Chemist, three Foremen, one Spinning expert, two Assistant Engineers, two Assistant Chemists and four Laboratory Chemists. For a 10 tons plant, the number of other technical staff required is between 15—30. In addition one analytical chemist incharge of analysis and tests on raw materials and products at various stages of manufacture is needed.

If we assume that the ' other technical staff ' stated above comprises Junior personnel—spinning technologists (textiles) and engineering operators in equal proportion, the requirements for staff for all the 710-ton units projected by the Panel may be estimated as :—

Senior or Executive personnel—	
Engineers-Mechanical and Electrical	21
Chemists and Chemical Technologists (cellulose)	56
Textile Technologists (Rayon)	28
Junior personnel—	
Textile Technologists	105
Engineers—Mechanical and Electrical	105

24. It is to be noted that the bulk of the technical personnel required for the industry are men, who possess both scientific knowledge and practical training in the manufacture of rayon in all its various stages.

*NOTE.—For the three Rayon Factories now under consideration the Ministry of Industry & Supply has estimated the requirements as follows :—

Chemists	20
Operators	300
Chemical Engineers	20
Mechanical and Electrical	20

Training of Personnel

25. The training of such a large number of personnel should receive urgent consideration. It is next to impossible to organize such training abroad for our nationals for many reasons of which the most important is that no rayon factory abroad is prepared to provide training facilities since the processes are still regarded as trade secrets everywhere. Under these circumstances we have some how to organise the training facilities in this country itself notwithstanding the fact that we have to start from scratch.

26. Although rayon belongs to the general group called Textiles, there is no comparison whatsoever between the cotton textile industry and the rayon industry, especially in the process of manufacture. Compared to the relatively simple operations which are mainly mechanical of cotton spinning, rayon spinning is a highly complicated and specialised chemical operation, the weaving part is only on appendix operating after the yarn has been made. In view of the complex nature of the rayon spinning machine which is an ingenous piece of machinery, it is essential that those who are to run rayon plants should have an adequate theoretical knowledge and sufficient first hand working experience of this specialised

stage of the industry. The theoretical instructions, which covers the general field of cellulose chemistry and technology, will have to be organised in an institution specially selected for the purpose. In the matter of practical training, as has already been mentioned, rayon factories abroad are least likely to provide necessary facilities for practical training.

27. Until the factories are established in the country, the only practicable way to organize practical training is with the help of rayon pilot plants, which should be installed in the institution in which the theoretical training is imparted.

28. Special mention must be made here of research in rayon and allied cellulosic products. Research is the back-bone of all industrial development and specially so in rayon industry. Conditions obtaining in the country in the matter of raw materials, etc., are so different from those prevailing elsewhere that research—both fundamental and developmental—should be an essential part of the organisational set up of the industry right from the beginning. Under the existing circumstances no single concern or even a group of concerns engaged in rayon manufacture in the country is in a position to embark on any comprehensive and long-range programme of research for the general development of the industry and much less, plan, initiate, finance and execute such research projects. The effort will have to be made entirely by the Government of India through the officially sponsored research organization, namely, the Council of Scientific and Industrial Research, much the same way as has been done for other industries, such as chemical, metallurgical, fuel, glass and ceramics, drugs, etc., for which National Laboratories have been established.

Institute of cellulose technology and research

29. The foregoing considerations lead us directly to the conclusion that for the dual purpose of providing trained technical personnel for rayon industry in the country and for carrying out co-ordinated and planned research for the development and progress of the industry, a *Central Institute of Cellulose Technology and Research* should be established in the country. This Institute should concern itself with other cellulose products also.

30. It is suggested that the above institute may well be set up at Coimbatore which possess certain obvious advantages, *e.g.*, existence of a flourishing textile industry, of technical institutions and the proximity to the proposed rayon factories. It is believed that land and temporary buildings can be had at this place free of cost for this purpose.

Woollen Textiles

31. Woollen goods manufactured on cottage industry basis forms by far the bulk of output of this industry. The first mechanised units were, however, installed about 70 years ago at Kanpur and Dhariwal. During the last 20 years the industry has made good progress, and the temporary impetus given by the two world wars was utilized to the maximum advantage consistent with the availability of machinery and technical staff.

Present Position.—Before the war there were about 15 major concerns distributed all over the country but mostly in the Western Zone and the Northern Zone. The present installed capacity has been estimated at about 50,000 woollen spindles and 37,500 worsted spindles. The types of products range from carpets, woollen yarn, blankets, shawls to serges, woollen hosiery, worsted suitings and flannels etc. The industry suffers from two handicaps ; namely lack of indigenous yarn of finer counts and better quality and lack of trained personnel for the manufacture of the worsted cloth, particularly. Pre-war average imports have been of the order of 11 million lbs. whereas the indigenous production of various types of goods was only 7.9 million lbs.

Technical Staff Employed

32. It is not possible to ascertain the total technical staff employed in the woollen textile industry. However, for the purpose of working out a representative production to personnel ratio, the spindles installed and personnel employed in five important concerns in the Northern and Western Zones have been taken into consideration and we obtain the following figures.

For 10,000 spindles staff requirements are : Two engineers, 3 textile technologists and two chemists

None of the concerns has given the number of supervisory staff employed by it but from a knowledge of the industry it can be presumed that for every superior type of technical executive there would be at least three supervisors to assist them in the day to day work of the factory. The total staff requirements for 10,000 spindles can therefore be taken as 7 senior or executive type of technologists and 20 junior or supervisory type of personnel.

Development and expansion

33. We propose to take an overall picture of expansion of this industry in India and not to consider the development projects of individual concerns, although information has been received from some of the concerns that they propose installing additional spindles. The industrial Panel on Woollen industry has reported that sanction has already been given for the installation of 98,000 spindles (both for woollen and worsted) and they feel that with the existing capacity and the new sanctioned capacity India should be able to meet her requirements. The position has to be considered from the point of view of availability of raw materials also. On the basis of other considerations it has been recommended that the existing and the new units should work double shifts so that maximum production can be obtained from the installed machines.

Pattern of employments and assessment of personnel

34. The scientific and technical personnel required in the industry can be grouped under three categories, textile technologists, engineers and chemical technologists having experience of dyeing and bleaching of wool. On the basis of the production to personnel ratio we estimate that for the additional spindles which have been sanctioned the requirements would be for 70 senior or executive technological staff and 200 junior or supervisors type of staff. In the event of the firms, new and old, introducing double shifts following the recommendations of the Panel the additional requirements for staff would be—

(*a*) for the existing concerns for double shift

Senior or executive type of personnel	60
Junior or supervisory type.	174

(*b*) for the new installations

Senior or executive type	70
Junior or supervisor type	200

35. Combining the staff requirements for additional units and double shifts we arrive at the following figures :—

Textile technologists	86
Engineers	57
Chemists	57
Junior textile technologists	150
Junior engineers or foremen	112
Junior chemists	150

NOTE.—As regards the assessment of personnel the Ministry of Industries and Supplies state as follows :—

" In view of the climatic conditions woollen industry has a limited scope for expansion in our country and further development will lie mostly in increasing our production of yarn and worsteds and mixed goods. The Panel of woollen industry in their report estimates that some 45 persons may be sent for higher training in different branches of the industry for absorption in the mills during the next 5 years and the different branches in which these personnel are to be trained are as under :—

Branch of Training	No. to be sent
1. Sorting	5
2. Blending, with special reference to short staple and reclaimed wools, carding, spinning.	10
3. Wool scouring, worsted carding, combing, drawing and spinning including combing, drawing and spinning on the continental system.	10
4. Weaving and designing	10
5. Dyeing and Finishing	10

We have no reasons to go beyond that. Besides, we are drawing up a scheme for a technological institute for training in woollen industry and our aim is that the proposed institute should turn out sufficient personnel to meet the demands of the woollen industry including hosiery.

Industrial training

36. Assuming that the requirements for staff will be even over the 5-year period the industry will require annually 17 textile technologists with experience of carding, spinning and weaving of wool, 12 engineers (mechanical *cum* electrical) and 12 chemists with experience of bleaching, dyeing and finishing of woollen cloth. There is an undoubted dearth of trained technologists in this field and our future training arrangements should, therefore, take into account the maximum advantage of facilities available in the country. Generally speaking the industry is in favour of imparting training and it is felt that each large woollen mill has sufficient facilities for the training of four technologists, two chemists, and two engineers.

Hosiery Industry

37. During the past decade the hosiery industry has established itself in various parts of India mostly on a cottage industry basis. Before the war there were fewer power driver knitters than at present. The factors limiting the development of this industry are the shortage of yarn and the non-availability of hosiery machinery and spare parts, the import of which was considerably cut down due to war situation. It should be mentioned here that during the war time some progress has been made in the indigenous manufacture of hosiery machinery.

38. The chief centres of this industry are in East Punjab, United Provinces, Bombay, West Bengal and Madras. The factories in U. P. and Bombay are fewer in number but larger in size whereas in the other areas there are smaller factories scattered all over the place. Cotton, woollen, silk and artificial silk knitted goods are manufactured. Yarns for woollen, silk and artificial silk goods are imported whereas a substantial portion of the cotton yarn used by this industry is of indigenous origin.

Technical personnel employed

39. It has not been possible to assess the technical personnel employed in this industry. Most of the concerns do not employ any technical person. They require personnel trained in the use of knitting machines and this skilled labour is usually trained by the concerns themselves. Some of the larger concerns employ engineering personnel (usually mechanical/electrical engineers) to look after the knitting machines. These larger units, are however usually appendices to big textile mills which supply the yarn and the technical service.

Development

40. According to the Industrial Panel Report on Hosiery industry the target figures for production in 1951 are :—

Underwear	100 million pieces.
Outer-wear	100 million pieces.
Foot wear	50 million pairs.

On an average between 60 to 80% of this target production should be cotton hosiery and about 10 to 20% woollen hosiery and 10% silk or rayon hosiery. The Panel was of the opinion that if the industry could increase its output to these figures, the country would not have to depend on imported hosiery and would be in a position to export to nearer markets. According to their estimate about 15,500 additional knitting machines will have to be imported to attain the target production.

Assessment of personnel

41. Since the development of this industry is likely to take place mostly on a cottage industry basis or as adjuncts to textile mills, we feel, that there will be no special need for trained scientific and technical persons for the development of the industry. The existing institutions at Ludhiana, Kanpur, and Serampur can provide the necessary training for the type of craftsman needed. The Industrial Panel has however, recommended that additional grants be sanctioned to expand the above training facilities. Trained hands would, however, be required to staff the research organization the establishment of which has been recommended by the Industrial Panel. These requirements have been taken into consideration elsewhere in this report on the assumption that the recommendation will be accepted and implemented within the next five years.

Jute Industry

42. The production of jute fibre is a very important agricultural industry in the Eastern zone. On account of climatic and other reasons the jute factories have been concentrated mostly in and around Calcutta. Only 3 are located in Kanpur and three in Bihar.

43. It is regretted that attempts to collect information about this industry have proved infructuous.

44. The technical personnel usually employed in the Jute Mills comprises of engineering personnel (mechanical or electrical or both) chemist, chemical engineer or textile engineer. With the loss of major jute producing areas consequent on the partition of Bengal, some of the jute mills are finding it difficult to work to the full capacity. It is not impossible that during the next five years the activities of this industry might be somewhat on a reduced scale than otherwise. It may be presumed that during the next five years the industry will not require additional technical staff.

Subsidiary Industries such as Ginning Mills, Woollen Presses, etc .

45. The ginning presses and similar allied industries are very widely distributed in the rural areas of the country and perform a very important function as subsidiaries to the textile industry. Such presses numbered about 1500 in 1944-45. On account of the increased production of textile and jute in subsequent years it is possible that this number has increased slightly.

46. From a sample survey of some of the concerns in one zone it appears that on an average each concern employs one mechanical or electrical engineer. In some concerns only an engineering diploma holder or even a trained mechanic is employed. The work of these presses is of seasonal character, the units being very busy when the cotton crop is harvested.

47. The textile industry is aiming at an increase of about 30% in production during the next five years. It is reasonable to assume that the activities of cotton ginning and pressing will increase in the same proportion, *i.e.* 30%. For this increased activity we estimate that an additional engineering personnel of 450 (mechanical/ electrical engineering degrees/diplomas) will be required for the next five years.

H. Glass Industry

1. The articles produced by the Indian glass industry are bangles, hollowware including lamp ware, table ware and bottles, sheet glass, pressed ware and fancy goods as well as shells for electric bulbs, scientific apparatus, etc. The industry generally is rather backward and there is need for its improvement and expansion. The progress depends on the industry employing qualified technical personnel for the proper standardisation and purification of sand for making glass ; on the introduction of automatic machines, efficient recuperative and regenerative furnaces ; and on the provision for adequate research facilities.

Present Position

2. A large number of factories working on small cottage-scale produce bangles, small bottles, tumblers, glass chimneys, etc. They obtain glass from bigger producers and remelt it for use. Other than these there are a number of factories fairly evenly distributed all over the country. They manufacture articles such as sheet glass, pressed wares, bottles, scientific and medical glass equipment etc. Information from the completed questionnaires received have been tabulated in appendix. The position, however, zonewise may be summarised as follows :—

TABLE I

Zone	Production	Technical staff employed	
Northern Zone	1200 tons (1 concern) worth Rs. 39 lakhs (8 concerns).	Executive Technical Personnel	5
		Chemists	6
		Glass technologists	4
		Ceramist	1
		Engineers	10
		Glass Technicians, Supervisors & Foreman	18
		Unclassified personnel (fitters, turner, foremen) (8 concerns).	38

Zone	Production	Technical staff employed	
Western Zone	50,000 bottles and 50,000 ampules (one concern) Worth Rs. 4-5 lakhs (one concern).	Technical Executives	2
		Glass technologists	9
		Electrical Engineers	3
		Mechanical Engineers (4 concerns)	4
Southern Zone	1220 tons of glass and glass bottles (2 concerns).	Glass technologists	4
		Engineers (2 concerns)	2
Eastern Zone		Glass Technologists	6
		Engineers (2 concerns)	6

3. A number of these concerns employ automatic or semi-automatic presses and some of these are making efforts to place the industry on firm scientific basis but the progress has so far been slow. It should be noted that optical glass, chemical glass-ware and other specialised type of glass and glass products are not being manufactured in the country and that modern types of recuperative and regenerative furnaces have not been installed in many factories. The quality of glass-wares is generally speaking unsatisfactory and is due to the lack of standardization and proper quality controls and the use of primitive furnaces.

Technical staff employed

4. The number of technical staff employed in the glass industry of the country is negligible. A few trained technical executives and other senior persons are employed in some of the uptodate factories but the rest of the staff consists of only skilled and semi-skilled operators. For the purpose of this survey special study has, however, been made of two concerns who employ qualified technical staff and whose production is fairly standardized. We find that for the production 1000 tons of glass products per year staff requirements are three technologists and two engineers.

5. It should be noted that in the present state of its development, the industry does not employ fuel technologists and furnace experts. If the industry is to improve and expand it is necessary that fullest use should be made of this type of personnel. It is believed that the industrialists are beginning to realize the important role which fuel technologists and furnace experts can play in this industry.

Development and expansion

6. The immediate programme of development and expansion of glass industry centres round (a) increase in production, (b) installation of automatic machines, and (c) manufacture of sheet glass. A large number of concerns have given their individual programme but we feel it would be better to discuss the development of the industry as a whole. Leaving aside the manufacture of utility wares on a mass production scale which is necessary, the manufacture of special type of glass like optical glass, chemical and laboratory glass, fibre glass etc. has come to be an important aspect of modern glass industry particularly from the defence point of view. For further development, therefore, stress should be laid on two courses *viz.* (a) improvement of the quality through proper standardization and purification of raw materials and scientific control of glass melting, and (b) introduction of fully automatic machines and efficient types of furnaces for melting and annealing. The Industrial Panel on glass has fixed the following targets of annual production to be achieved during the next five years :—

Bangles, beads, bottles, pressed-wares	1·5 lakh tons.
Sheet glass	42 million Sq. ft.
Plate and figured glass	4 million sq ft.
Scientific glass apparatus worth	Rs. 10 lakhs.
Glass globes	25 million pieces.

7. It is not possible for us to determine what extent of the above target would be attained by expansion of the glass industry in various zones. The Industrial Panel for glass has, however, proposed the establishment of several new factories at suitable places in the country. What is, however, more important in the context of the present report is that the scope for the expansion of the industry extends far beyond that envisaged by existing concerns and the targets suggested by the panel may be taken as those representing the possible scale of development of the industry during the next 5—10 year period.

Pattern of Employment and Assessment of Personnel

8. Glass manufacture needs technical workers of 3 different categories *viz.*, chemists, glass technologists and fuel and furnace engineers. A rational well integrated development of the industry can only be brought about by the co-ordinated efforts on the part of the above three types of technical personnel. On the basis of production target fixed by the Panel we estimate the requirements as follows. In arriving at these estimates we have taken into consideration the possible expansion of the existing units.

TABLE I

Glass technologists and chemical technologists	180
General mechanical engineers with specialised knowledge of automatic or semi-automatic machinery used in glass industry	60
Fuel and furnace technologists	25
Operators of the foreman type of personnel (glass operators)	225
Operators of foremen type of personnel (Engineering)	100

Industrial Training

9. We have ascertained from the leading industrialists that the larger concerns could easily take in about 4 to 6 candidates for training, the duration of the training being 6 months to one year. For training in mass production methods, manufacture of special type of glass, furnace design and construction, fuel technology, etc. it will be necessary to send for training abroad a few selected young men, preferably from the industry. It may be mentioned here that the Central Government has alraedy sent 22S tate Scholars for training in U. S. A. and U. K. during the last 3 years. These students after finishing their training would return home shortly. It is felt that the industry should make use of these trained men to improve their products.

10. The following firms have expressed their willingness to take trainees :—

(1) Khandelwal Glass Works, Sasni, Aligarh ;

(2) Capital Glass Works, Ghaziabad ;

(3) Ganga Glass Works, Ballawati, U. P.

(4) Paisa Fund Glass Works, Talegaon ;

(5) Ogle Glass Works, Ogalewadi ;

(6) Sodepur Glass Works, Calcutta ;

(7) Shri Durga Glass Works, Barang P. O. ;

(8) Mysore Glass Works, Bangalore ;

(9) Ogale Glass Works Udogamandal, Alwaye, Travancore.

It can be presumed that most of the these factories can take in at least four students for 6 months to 1 year. It would thus be seen that if full advantage is taken of the training facilities available in the country we can make arrangements for the training of 44 persons per year. As a result of our discussions with leading technical executives in the glass industry, we have come to the conclusion that it will be necessary to arrange for the training abroad in the following specialised subjects :—

Mass production methods of manufacture of glass products	5 mechanical Engineers.
Manufacture of special type of glass such as optical glass, fibre glass & chemical glass ware, etc.	10 glass technologists.
Fuel and furnace technologists with special reference to glass industry	8

NOTE.—The Ministry of Industry and Supply have estimated the requirements as follows :—

Glass Technologists and Chemical Technologists	95
General Mechanical Engineers with specialised knowledge of Automatic & Semi-automatic machinery used in glass factory	55
Fuel and Furnace Technologists	18
Operators of the Foreman type (glass)	180
Operators of the Foreman type (Engineering)	90
Analytical Chemists	80

J. Ceramics and Refractories

11. The ceramics and refractories industry covers a wide range of products such as domestic wares, crockery, sanitary wares, chemical procelain, insulators, refractories, roofing and flooring tiles, etc. Depending on the type of raw material used and the process of manufacture the products can be classified into stone-ware, porcelain and refractories. These are "silicates" and are manufactured in kilns at high temperature.

Present Position

12. The industry follows the traditional methods and employs hardly any scientific or technical personnel. The industry as it exists today is a very significant one in the general economy of the country.

13. An analytical statement of the information obtained from the principal ceramic and refractory concerns in the country is given in Appendix————.

Briefly they may be summarised as follows :—

Name of the Zone	Annual production	Staff employed	
Northern (2 concerns)	Worth Rs. 6,00,000 (1 concern)	Chemists	2
		Ceramists	1
		Foremen (Engr.)	3
Western (2 concerns)	34420 tons	Pottery experts	2
		Chemists	12
		Engineers	7
Southern (6 concerns)	2720 tons (800 tons from 2 concerns, 1200 tons from 1 concern and 720 tons from 1 concern).	Chemists	17
		Engineers	9
		Chemists	3
		Mining Engineer and Geologists	2
Eastern (2 concerns)		Chemists	6
		Engineers	11
		Ceramists	3
		Metallurgists	5
		Geologists	2

14. High and low voltage electrical insulators, crockery, chemical porcelain, glazed tiles, refractories, acid jars, stone-ware, pottery stone-ware pipes, sanitary wares, etc. These can be listed as some of the lines of manufacture of these concerns.

15. It may be mentioned here that the concerns engaged in the manufacture utility articles such as roofing and floor tiles, stone wares, etc. are distributed all over the country, but the few concerns which manufacture specialised type of electrical insulators and porcelain of standard quality are mostly located in the Southern Zone, due mainly to availability of cheap electrical power and its use in electrical kilns in that zone. A large electrical tunnel kiln, which incidently is the first of its kind in the East, has been installed in one of the factories and a high voltage electrical testing laboratory for the routine testing of the insulators has also been attahced to this factory. The manufacture of refractory bricks, however has developed considerably around the coal fields and the most important factories for refractories are in the Eastern Zone.

Technical Staff Employed

16. The number and category of technical staff employed in the ceramic and refractory industry varies from one factory to another and depends on the type of products manufactured as well as on the methods of manufacture followed. Broadly speaking the products can be classified into

(*a*) porcelain, electrical insulators, and white ware.

(*b*) stone ware pottery, jars, tiles, etc.

(*c*) refractories.

The first group requires ceramists, electrical and mechanical engineers, chemists, mining enrineers and geologists, the second requires ceramists and geologists ; whereas for the 3rd group, chemists, engineers, ceramists, metallurgists, and geologists are employed. Geologists and mining engineers, however,

are engaged for securing mineral raw materials used in the manufacture of these products. It may be pointed out here that hardly any concern employs fuel technologists but for placing the industry on a sound, economic and scientific basis, this type of personnel requires to be employed. As a result of detailed study of some of the important concerns we find that :—

for an annual production of 1000 tons of porcelain 18 ceramists, 11 engineers and 4 chemists are required, and

for 1200 tons of stone-ware 3 ceramists.

(In the above ratios geologists and mining engineers are excluded but all foremen type of personnel is included).

For the production of 100,000 tons of various types of refractories a year 7 chemists, 13 engineeers 4 ceramic experts, 6 metallurgists and 3 geologists are requied (these figures do not include the operators of foremen type of personnel but it may be assumed that for each executive type or senior type of technical personnel 3 junior operators of foreman type will be needed. On this assumption the junior staff of various categories required is 100).

Developmentand Expansion

17. Some of the industrial concerns have planned their development and expansion projects. They have even specified the probable staff requirements but we feel that our conclusions based on the figures supplied by individual concerns will not give a completely integrated picture of the industry as a whole. Most of the concerns contemplate increasing the out-put of their present lines of manufacture whereas others are contemplating to introduce new products such as special refractories, high aluminia refractories, high and low temperature insulating bricks, etc.

18. In addition to the developments projected there is considerable scope for an all round expansion of the industry, specially, in the matter of high tension insulators, porcelain white ware and refractories. The demand for high tension insulators will increase considerably as the various multi-purpose hydro-electric generating and transmitting schemes develop. The demand for better quality of porcelain and domestic crockery is already on the increase and will increase still further as the standard of living of the people improve. Refractories, specially, the heavy duty ones, will be required in considerable quantities as metallurgical engineering, cement and chemical industries develop during the next few years. Keeping in view the position of industry in general the Industrial Panel on Ceramics and Refractories has fixed the following production targets for the next five years, over and above the present production.

Products	Increase in Production
White-ware.	5640 tons
Stone-ware .	5400 ,,
Insulators .	6225 ,,
Rerfactories	200,000 ,,

Pattern of Employment and Assessment of Personnel

19. The development of ceramic and refractories industry in all progressive countries has been the result of the co-operative efforts of different types of scientific and technical persons, specially, chemists, chemical technologists, ceramists, fuel and furnace technologists, electrical and mechanical engineers. In this country, too, all types of personnel except fuel technologists are at present co-operating to produce various articles of manufacture.

20. For the proposed development during the next five years, as out-lined above and on the basis of the targets of production indicated by the Industrial Panel we estimate the requirements as follows; making allowances for possible expansion of the existing units.

Senior or Executive type :—

Ceramists	97
Chemists and chemical technologists	50
Engineers electrical	40
Mechanical engineers	28
Fuel technologists	10
Geologists (As consultants)	5
Mining engineers (As consultants)	5

Junior or Operator type :

Engineers and supervisors	130
Ceramists	110
Chemists	60

Industrial Training

21. We have ascertained from the principal ceramic concerns their views about providing specialized practical training in industry. Almost all the concerns have expressed their willingness to afford the necessary facilities but the number of trainees and the period of training has not been specified in all cases. As a result of our personal visit to some of the factories, we feel, that the more important concerns can take about four ceramists or engineers for training for 6 months to one year. We give below a list of the concerns where technical training may be arranged :—

(1) Gwalior Pottery Ltd., Gwalior;

(2) The Perfect Pottery Co., Ltd., Jubbulpore;

(3) Parshu Ram Pottery Works Ltd., Morvi;

(4) Govt. Porcelain Factory, Bangalore ;

(5) Parry & Co., Madras. (This concern has offered to train two geologists also);

(6) Travancore Govt. Ceramic concerns;

(7) Burn & Co., Ltd., Refractories and Ceramic Works at Ranjiganj, and Jubbulpore;

(8) Reliance Fire Bricks and Pottery Co., Ltd., P. O. Chirkunda, Dist. Manbhoom;

(9) Bihar Fire Bricks and Pottery Ltd., P. O. Mugma, Distt. Manbhoom.

From the above we find that if the available facilities of the country are adequately utilized we can train 40 ceramists and chemical technologists every year or 200 during the next five years. As our requirements are for a slightly smaller number, we feel that adequate training facilities are available. For those specialised items which are not at present being manufactured in the country we have to make arrangements by training nationals in various universities and industrial concerns. As a result of discussions with leading industrialists we estimate the requirements of students to be trained abroad as follows :—

Subject	No. to be trained abroad
Ceramics with particular reference to electro porcelain and superior quality pottery.	12
Refractories	12
Fuel & Furnace Technology	8

NOTE.—The Ministry of Industry & Supply estimate the requirements as follows :—

Senior or Executive personnel—

Ceramists	65
Chemists & Chemical Technologists	45
Engineers—Mechanical & Electrical	70
Fuel Technologists	10
Geologists (as consultants) & Mining Engineers (as consultants)	8

Junior Personnel—

Engineers & Supervisors	90
Ceramists	115
Chemists	50

K. Leather & Leather Goods

1. The production of leather and leather goods has been an ancient handi-craft amongst certain communities who turn out considerable quantities of leather goods annually. The vegetable tanned crust leather produced by the village industry is called bag tanned leather. The semi-tanned leather produced in the Southern Zone is called East India Tanned leather or 'kips'. About 90 % of the total production of 'kips'; valued at approximately Rs. 30 million, is exported. The export trade of India in raw hides and skins and semi tanned leather is a significant one and it has been estimated that if these were exported in fully tanned condition India would earn an additional amount of about Rs. 1·33 crores.

Present Position

2. The bulk of leather tanning is carried out on small cottage scale in most of the villages and this type of industry does not require any specially trained scientific or technical personnel. Manufacture of leather by the pit tanning and chrome tanning process, however, has to be carried out according to the scientific methods of processing. It is mainly carried out in big factories requiring a large capital investment. The industry is, however, concentrated in Kanpur, Calcutta, Madras and to some extent in Bombay. Pit tanned leather using vegetable bark is used in making soles and harness etc. Chrome tanning produces a soft, and light to medium leather which is then highly glazed on suitable machines. Similarly the manufacture of box and willow hides, calf and glazed kid, which are highly specialized products, has to be carried out under scientific control. But excepting a few large concerns, the industry, generally speaking, does not employ scientific and technical personnel. In most factories one technical man in an executive position manages the entire work of general technical supervision and production. The rest of the staff consists only of skilled workmen.

3. An analytical summary of the questionnaires returned by this industry may be seen on appendix————. The position, however, is summarized as follows :—

Name of the Zone	Production	Staff employed	
North Zone	Worth Rs. 65·5 lakhs (4 concerns)	Tech. Executive	1
		Chemists	2
		Physicists	1
		Tanner	1
		Foremen	2
		Unclassified	14
Western Zone	10 lakhs lbs. & 6.7 sq. ft. (one concern)	2 leather technologists.	
Eastern Zone	NO INFORMATION.		
Southern Zone	NO INFORMATION.		

4. Lest the incomplete information given above should give a false impression of the position of the leather industry, we reproduce below the production and consumption figures in the Dominion of India.

Item	Production	Consumption	Remarks
Raw Hides	21·69 million	24·0 million	Deficiency met mainly from hides produced in the area now under Pakistan.
Raw Goat & Sheep Skins	39·2 million	23·3 million	Balance exported as now.

6. It would also be noticed that India is practically tanning all the buffalo hides and sheep skins. Goats' skins are tanned as far as demands and processing facilities permit. Goat skins are used for the manufacture of glazed kid leather and this industry is practically localised in South India. This stunted growth is reported to be due to lack of technical skill and trained operators. It is very necessary to develop the manufacture of glazed kid leather so as to be able to process the available goat skins.

7. Wattle bark has become an important vegetable tanning material. India is so far dependent on its import from Africa. During war time some substitutes have been tried with varying degree of success but the industry feels that cultivation of wattle bark should be undertaken in the country.

Technical Staff Employed

8. For a proper and fuller utilization of the resources of the country the types of scientific and technical personnel required in other countries are :—

(*a*) Leather technologists,

(*b*) Biochemists, having a knowledge of protein chemistry,

(*c*) Organic Chemists with experience of tanning materials and proteins,

(*d*) Mechanical engineers,

(*e*) Supervisors for supervising the tanning operations, processing and finishing operations.

*Note.—The Ministry of Industry & Supply state that the normal requirements of leather industry are as follows :—

1. Leather Technologists (including experts in the manufacture of leather goods and footwear).
2. Supervisors for various operations in the tanning and leather manufacturing industry.
3. Mechanical Engineers of Mechanic type for the maintenance of machines used in the industry.
4. Chemists with general knowledge of organic, inorganic and physical chemistry (for the tanning industry).

The industry does not employ technical personnel of various categories in sufficient number. On account of this incomplete information we have not been able to work out any production to personnel ratio as obtains in this industry.

Development Programme

9. We have not been able either to obtain any development programme of the various industrial concerns who have replied to the questionnaires. The majority of the big concerns, in Kanpur, Calcutta and Madras, have, however, not been working to their fullest capacity on account of shortage of raw hides. This shortage has been created by bag tanning or half tanning of hides in the villages etc. The Industrial Panel on leather and lea'her goods, however, has suggested the target prduction figures of various types of tanned leather as follows :—

Description	Pre-war production	Post-war Target for 5 years
'Bag' Tanned Leather	9.10 million hides	9.55 million hides.
E. I. Kips	8.60 ,, ,,	8.60 ,, ,,
Pit tanned heavy leather	1.24 ,, ,,	2.70 ,, ,,
Crome Tanned hides	2.53 ,, ,,	6.30 ,, ,,
Glaze kid leather	1.14 ,, skins	4.14 ,, skins

The Panel considers that these targets can be achieved by banning export of raw hides, by organizing bag tanners into cooperative societies and giving them technical help through mobile demonstration parties. By far the largest amount of tanned leather is used in the manufacture of shoes.

Corresponding figures for leather footwear are as follows :—

	Pre-war production	Post-war production
Indigenous types	701 million pairs	200 million pairs.
Western Types	30 million pairs	45 million pairs.

10. Amongst other leather goods the most important ones of industrial and commercial utility are leather machine belting and cotton pickers. Civilian goods such as trunks, suit-cases, hand-bags, purses, harness and saddle-ware consume considerable amount of tanned leather. An increase in the production of these goods varying from 75—100% has been recommended by the Industrial Panel.

11. Amongst the by-products of the industry mention may be made here of glue, which is of considerable industrial importance. The prewar imports of glue prewar were of the order of 15,000 tons. Increased production of glue should be undertaken to the extent of additional 700 tons.

Pattern of Employment

12. We have been unable to obtain adequate factual data on Production and technical personnel employed in the various leather manufacturing concerns in the country. Consequently, we are unable tc arrive at a production to personnel ratio which might be taken as a basis for the assessment of the requirements for technical man-power. Besides, as has been stated earlier, the industry as it exists at present leaves much to be desired and needs to be properly reorganised on right scientific lines through employment of suitably qualified technical personnel ; and consequently, the assessment should not be based on existing conditions of the industry.

The Industrial Panel has made a total estimate of requirements at the end of 5 years for administrative, higher technical and lower technical personnel (excluding unskilled workers) which is as follows :

TABLE I

	Administrative personnel	Higher Technical Personnel	Lower technical personnel excluding unskilled manual workers
1. Pit tanned buffalo leather	140	700	1,470
2. Half tanned E. I. Kips	286	1,287	2,288
3. Half tanned goat and sheep skins	218	981	1,744
4. Chrome tanned cow hides and calf skins	200	1,200	3,500
5. Glazed kid and chrome suede	22	132	389
A. Total Leather	866	4,300	9,391
B Footwear	300	2,100	13,500
C. Other leather goods	1,100	3,100	19,800
Grand Total (in round figures)	2,300	10,000	33,000

13. If in the above the lower technical personnel are considered as trained technicians and skilled workers, the total Scientific & Technical manpower required for the development of leather industry according to the Panel comes to about 3000. This estimate is in our considered opinion very much exaggerated for various reasons and especially because the targets suggested by the Panel before the partition of the country need to be revised in the light of the existing circumstances, and the reorganisation of the entire industry on right scientific lines can only be carried out in several stages spread over a number of years. We believe that our requirements for technical personnel for the development of the industry during the next 5 years would be as follows :—

Senior or Executivee personnel	
Leather Technologists including specialists in Footwear manufacture	250
Leather Chemists	50
Junior personnel	
Leather Technologists including personnel trained in footwear and leather goods manufacture	400
Engineer Operators	100

*Note.—The Ministry of Industry & Supply estimate the requirements as shown below :—

Grade I Technicians (Leather Technology)	10
Grade I Technicians (Footwear)	20
Grade II Technicians (Leather Technology)	35
Grade II Technicians (Footwear)	40
Grade III Technicians (Leather Technology)	100
Grade III Technicians (Footwear)	200
Engineering Mechanics	90
Chemists (For Tanning Industry)	15

Industrial Training

14. The few firms that have replied to the questionnaire have expressed their willingness to take trainees for practical training but the duration of their stay has not been specified. As a result of our visit to the industrial concerns we are of the opinion that each large tannery is capable of arranging for the training of 6 to 8 men for a period of 6 months to one year. We feel it would be desirable to enforce the practical training scheme on all tanneries of importance. If this suggestion is accepted then practical training facilities can be enforced at least in 43 important concerns, and in this way we will be able to train about 300 students per year in various aspects of leather technology. But it is to be admitted that, generally speaking, facilities for training are extremely inadequate. The theoretical training is imparted by Provincial Leather Technology Institutes, namely, Madras Leather Institute, the Bengal Tanning Institutes, the Bombay Tanning Institute and the Jullundur Tanning Institute. An all round expansion of training facilities is, therefore necessary and the present shortage of qualified technologists may be met by sending tanning demonstration parties to give instruction on improved methods of training to villagers engaged in bag tanning on cottage scale.

15. As far as research is concerned it may be noted here that besides the Leather Technology Institute at Madras, the Madras University has started advanced training in leather technology and the Council of Scientific & Industrial Research is shortly establishing a Central Leather Institute at Madras.

16. Simultaneously with the development of industry on sound scientific lines the education and training in leather technology in various institutes and industrial concerns should be properly reoriented and co-ordinated with needs of the industry. Practical aspect of training should obviously be given top consideration in the training courses. It has been suggested by leading industrialists that every student should undergo at least one year's apprenticeship in a recognised tannery before obtaining the diploma or degree.

17. We would like to refer here to the need of training of Indian personnel abroad in leather technology abroad. The facilities and resources available in the country are considered inadequate for this purpose. Students should, therefore, be sent abroad for further training in research work connected with improved methods of tanning and to obtain actual experience in modern tannery practice in well advanced countries. The students should, as far as possible be selected from the industry provided they have had the requisite theoretical training and back-ground. One aspect of leather tanning, however, to which we would draw attention again is the need of developing technique for the manufacture of glazed kid leather. This is a highly specialized subject and the requisite technical skill and knowledge is available in one or two concerns only. On account of this deficiency considerable quantities of goat skins are exported abroad.

Subject/Field of Training	Number to be sent abroad
Special aspects of leather tanning such as mineral tanning, manufacture of glazed kid leather etc.	8 leather Technologists.
Manufacture of concentrated tanning extracts. Synthetic tanning Compounds etc.	4 chemists.
Manufacture of Foot wear on mass production scale	4 Footwear Specialists.
Fabrication of leather manufacturing and Footwear and leather goods manufacturing machinery.	4 Mechanical Engineers.

L. Engineering Industries

Introduction

1. In this section we shall deal with industries concerned with the production of machine tools prime movers, electrical machinery and measuring instruments, wireless transmitters and receivers, telephonic equipment, automobiles and tractors, ships (including repairs), aircraft (including repair), industrial plants and machinery, bolts, nuts, etc., hand tools etc. and light engineering industries. We shall also consider in this section the organisation concerned with generation and distribution of electrical energy.

2. The engineering industries are of primary importance in the economic development of the country as they are concerned with production of tools and machinery on which almost all the other industries depend. Unfortunately, however, the engineering industries are yet in a poor state of development and whatever development there is, is mainly concentrated in the Eastern Zone which accounts for a large proportion of the total production.

3. Since most of the major manufacturing concerns are engaged in the production of more than one class of goods, it has been found difficult to correlate production figures with the technical man-power. The other difficulty has been the reluctance manifested by the industries to furnish detailed information. In most cases even repeated personal calls have failed to produce the necessary response. Effort has, however, been made to give as fair an estimate of the requirements as possible in the circumstances.

Prime Movers

4. This industry is concerned with the production of prime movers, *i.e.*, Steam engines and I. C. Engines, Steam Turbines and Gas Turbines, Hydraulic Turbines and auxiliary equipment such as Steam Boilers and its accessories, Pumps, Air Compressors, etc. Prime Movers in large numbers and covering wide ranges of power are required for agricultural development, for the development of cottage industry, in sugar, textile, tea and jute industries as well as for the development of land and water transport and also for the very important "nursery" power development schemes for generation of electricity.

Present position

5. India has at present a capacity for producing about 700 diesel engines of Horse Power ranges upto about 120 B.H.P. every year but the actual production is only about 500. Arrangements do not exist for the manufacture of diesel engines of higher horse powers. The only important Diesel Engines Manufacturer is the Cooper Engineering Co.,Ltd., of Satara.

6. We have no factories engaged in the manufacture of petrol engines, steam engines or turbines A few small water wheels, pumps, boilers and other auxiliaries are, however, manufactured but their production is insignificant both in quantity and quality. We are, for all practical purposes, solely dependent on foreign imports for our requirement of prime movers and their auxiliaries.

7. It has not been possible to obtain separately the number of technical personnel employed in this industry as production of engines and auxiliaries form only a part of the industrial activities of firms concerned.

Development Plans

8. Only two of the Engineering firms who have replied to our questionnaire produce Diesel Engines; they are the Cooper Engineering Co., Ltd., Satara and Messrs S. Daji & Co. of Kolhapur. Between them, they employ—

18 engineers
5 junior engineers
2 metallurgists, and
3 chemists

Both these firms have plans for expansion and the staff required for their Engine manufacturing section is :—

6 engineers, and

2 metallurgists

9. During the first five-year period of development as proposed by the panel for this industry India should produce annually 9,060 oil engines of an aggregate capacity of 4,00,000 H. P. millions and 56 steam turbines of an aggregate capatcity of 2,55,000 K.W. The Panel recommends doubling the out put during the second five-year period and quadraupling it during the third.

10. We estimate that the following technical personnel will be required to achieve the first two five year targets of production.

Mechanical Engineers	150
Electrical Engineers	20
Metallurgists	15
Fuel Technologists	20
Junior Engineers	300

11. Of these Engineers, some should be specialists in design and others in production. The panel has recommended that during the first five years experienced men should be sent for training in certain specialised subject, particularly in the design of Turbine Plants, Reciprocating Steam Plant, Jigs and Tools, Boilers, Boiler Auxiliaries, High Speed Oil Engine for land and marine use, Pump Machinery, Hydraulic Power Plant, Water Treatment Plants, etc. We are of the opinion that possibly ten to fifteen men should be sent each year for foreign training in these subjects during the next two or three years.

Government Plan

12. An important development is envisaged for the production of aero-engines and internal combustion engines in a State-owned factory in which it is proposed to manufacture petrol engines between 250-500 H. P. and I. C. engines of 500 H.P. and above. The scheme is expected to cost about Rs. 2 crores in capital expenditure. We estimate that the next five -year period is likely to require about—

Mechanical Engineers	50
Electrical Engineers	20
Metallurgical Engineers	5
Chemists	10
Junior Engineers	150

Requirement for Technical Personnel

13. Thus our overall requirement for the next 5-10 years is

Mechanical Engineers	200
Electrical Engineers	40
Metallurgists	20
Chemists	10
Fuel Technologists	20
Junior Engineers	450
TOTAL	740

Machine Tools

14. From the point of view of production of capital equipment, this is probably the most important of the various engineering industries. Even though the actual production of machine-tools in the year 1946 rose to 8,810 machines valued at Rs. 1·75 crores the industry is still in its infancy and concerns itself almost wholly with the production of simpler types of machine-tools. It is estimated that the production covers only about 3 per cent. of the types and ranges of machine-tools required in the country and that it falls far short of the existing demand for even the simpler types of machine-tools. It is understood that while import licences worth more than Rs. 9 crores were issued in 1947 for the import of machine too's, the value of actual import is estimated at Rs. 1 crore only. There is, therefore, a considerable volume of unsatisfied demand for this class of goods.

Present position :

15. There are in India over 200 firms engaged in the production of machine-tools but only ten of these can be regarded as manufacturers of 1st grade products, and seven of second grade. The important firms manufacturing machine-tools in the Eastern Zone are :—

(i) India Machinery Co.,
(ii) Britannia Engineering Co.,
(iii) Alfred Herbert India Ltd.,
(iv) Maya Engineering Works,
(v) Atlas Work,
(vi) Jessop & Co., Ltd.,
(vii) Batala Engineering Co.,
(viii) Heroes Engineering Works.,
(ix) Hind Machines Ltd.,
(x) Jay Engineering Works Ltd., and
(xi) Shedi Works Ltd.,

They produce small Centre Lathes, small Capstan Lathes, Pillar type Drilling Machines, Shaping Machines, small Planing Machines, Slotting Machines, small Universal Milling Machines, Power, Presses, Band and Circular Saws, Chucks etc. Of the total 1946 production estimated at Rs. 175 lakhs the production of the Eastern Zone alone amounted to about Rs. 1 crore.

16. The only important manufacturer of Machine Tools in the Southern Zone is the Mysore Kirloskar Ltd. Manufacturing Centre Lathes, Drilling Machines, Shaping Machines, Planing Machines and small Power Presses.

In the Western Zone

(i) Cooper Engineering Co. Ltd.,
(ii) Investa Machine-Tools and Engineering Co. Ltd.,
(iii) Messrs Richardson & Crudas, and
(iv) Practical Engineering Co.

are the major manufacturers and produce Centre Lathes, Capstan Lathes, Drilling Machines, Shaping Machines, small Punching Machines, etc.

In the Northern Zone M. Ahmed Din & Bros. is the only important firm. Its range of products is not known.

Information could be collected only in respect of six firms of which three are manufacturers of first grade machine-tools. The technical personnel employed by them are :—

Mechanical Engineers	28
Civil Engineers	2
Senior Engineers (Unclassified)	45
Chemists	4
Metallurgists	4
Junior Engineers (Unclassified)	120

Our estimate of the technical personnel employed in this industry as a whole is

Engineers (mainly Mech. & Elect).	100
Metallurgists	10
Chemists	10
Junior engineers (Unclassified)	200

Development Plans:

17. We have not been able to ascertain the development plans of even these six concerns. It is understood that four of them are planning for a two-fold increase in their present production capacity. The majority of the firms have not replied to our questionnaire; nevertheless it was revealed by most of them in their discussion with us that they contemplated expansion. It is estimated that the requirements of additional staff for the industry as a whole for the next five-ten years may be as follows :—

Engineers (Mech. & Elect).	100
Metallurgists	10
Chemists	10
Junior Engineers	300

The above staff may be apportioned as follows :—

Mechanical Engineers (Machine Tool Designers)	15
Mechanical Engineers (Production Engineers)	15
Mechanical Engineers (General)	50
Electrical Engineers	15
Civil Engineers	5
Metallurgists	8
Chemists	10
Junior Engineers	300

Panel Recommendation:

18. According to the recommendations of the Panel on this industry, the target production for Machine-tools for the year 1947-48 is 7,225 units of different types. As mentioned earlier, the production for the year 1946 came upto 8,810 in 1946. The production has shown some decline in 1947 and only came to 6,000. The Panel has recommended that from the year 1947-48 onwards the manufacturing capacity should be increased steadily by 20 per cent. each year so that the production capacity may be doubled by the year 1953.

Government's Plan :

19. An important development that has taken place is that the Government is considering the establishment of a State-owned Machine-Tool Factory for the production of the more intricate types of machine tools. It has been proposed that this State-owned Factory should manufacture 50 per cent. of India's requirement for the following types of machines within five years and of the remaining types within ten years :—

Centre Lathes,

Tool Room Precision Lathes,

Capstan Lathes,

Combination Turret Lathes,

Radial Drilling Machines,

High Precision Milling Machines,
Motorised Planning Machines,
" Shaping Machines,
" Boring Machines,
" Different types of Grinding Machines and Power Presses.

Within the ten year programme proposed, this factory should also produce Gear shaping machine, Gear Hubbing Machines, forgin machines, Die Casting and Engraving machines, Electric Furnaces etc. The requirements for technical personnel for this proposed factory is not known to us but we estimate that the following personnel are likely to be required.

Metallurgists (Specialists in Steel casting)	5
Metallurgists (Specialists in non-ferrous Casting)	3
Metallurgists (Specialists in Heat-Treatment	2
Mechanical Engineers (Machine-Tool, Jigs and Fixture Designers)	10
Mechanical Engineers (Production)	10
Mechanical Engineers (General)	60
Electrical Engineers	20
Inspection Staff (Engineers & Metallurgists 10+2)	12
Chemists	5
Civil Engineers	5
Junior Engineers	150

Requirement for Technical Personnel

20. Thus overall requirements for technical personnel for this industry for the next five-year period is estimated to be :—

Mechanical Engineers (Machine Tool Designers)	25
Mechanical Engineers (Production Engineers)	25
Mechanical Engineers (General)	120
Electrical Engineers	35
Civil Engineers	10
Metallurgists (ferrous, non-ferrous, Heat-treatment)	20
Chemists	15
Junior Engineers	450
TOTAL	700

Cutting Tools

21. The Indian Tool Manufacturers Ltd., Bombay, is the only major concern which produces cutting tools although during the war a few firms were established in the industrial area of Calcutta. for this purpose. The value of Twist Drills produced in the year 1944-45 from all these concerns was Rs.7 lakhs as against the total consumption worth Rs. 11 lakhs. During the same period the value of the government purchase of other tools amounted to Rs. 2·7 lakhs as follows :—

	Rs.
Milling Cutters	39,000
Reamers	22,000
Taps	2,08,000
Dies	2,000

In the opinion of the small Tool Manufacturers Association the consumption of Twist Drills in the post-war years in India is likely to be less leaving India with an annual surplus worth about Rs. 8 lakhs. We are of the view that the manufacturers are unduly pessimistic and we estimate that for the efficient running of the cutting tool industry we should still require :—

Metallurgists	10
Mechanical Engineers (Machine Tool Experts)	20
Electrical Engineers	10
Junior Engineers	30

Hand Tools and Agricultural Implements.

22. The following hand tools are now manufactured in the country, namely, vice, chisels, Hammers, Spanners, Pick-axe, Hoes, Shovels, Plough shares, crow-bars, knives, etc. and also other agricultural implements. At one time most of above items were produced in the country by the indigenous cottage industry. The Agricultural Machine Company set up at Jamshedpur about 25 years ago are now capable of producing most of what India would require in the shape of simple hand tools and agricultural implements.

23. A number of other firms also produce these articles. We have received replies to one questionnaire from about a dozen firms, most of whom do not employ any technical personnel except when they are engaged in the manufacture of other engineering products also. We are, therefore, of the opinion that the requirement in this group of industry for technical personnel is likely to continue to be insignificant.

Wire and Wire Products.

24. This industry is engaged in re-rolling of billets and production of wires and wire products. The important factories are concentrated in the Eastern Zone and are engaged in the production of nuts, rivets, spikes, screws etc. The important firms doing this work are :—

Messrs Guest Keen & Williams Ltd.

Indian Steel & Wire Products.

The National Screw & Wire Products.

Messrs Burn & Co., Ltd.

Messrs Jessop & Co., Ltd.

Messrs Tata Iron & Steel Co., Ltd.

There are many other smaller firms specially in the Calcutta industrial area of Calcutta which are also engaged in the manufacture of bolts, nuts, rivets etc. The total production in the year 1944 is believed to have been about 21,000 tons as against the estimated requirement of 40,000 tons per annum. Many of these firms are engaged in the production of miscelllaneous engineering articles also. We are, therefore, unable to give an estimate of requirements for technical personnel for this industry.

Steel Fabrication and General Engineering.

25. There are in the country a number of big general engineering concerns like Messrs Jessop & Co., Garlick & Co., Richardson & Crudas Ltd., Braithwaite & Co., Burn & Co., etc. which are engaged in fabricating all types of steel structure in addition to producing machine-tools and other of mechanical equipment. We have a number of small firms allso who are engaged in this type of work. The six firms who have reported employ between them the following personnel :

Engineers (Civil, Mech. & Elect).	60
Junior Engineers	180
Metallurgists	4

Apart from the various important Governmental projects, for which fabricated structural steel will be required, there is an unsatisfied demand from the public, on a rough estimate for this industry, there will be required within the nest five to ten year period.

Civil Engineers	100
Mechanical Engineers	60
Electrical Engineers	20
Junior Engineers	300
Metallurgists	20

Miscellaneous Engineering Industry.

26. A large number of small firms are engaged in the production of castings, ferrous and non-ferrous and in doing miscellaneous jobbing work. Although our survey by no means can be said to be exhaustive, we have received replies to our questionnaire from as many as 33 concerns worthy of consideration under this category. The number of technical and scientific personnel employed in each of these firms is, however, small but we estimate that atleast 300-400 engineers are engaged in his general engineering industry.

For the all-round industrial development that is now contemplated we estimate that atleast a 1,000 engineers will be required during the next five to ten year period for engagement in this industry distributed as follows :—

Civil Engineers	80
Mechanical Engineers	150
Electrical Engineers	150
Junior Engineers	600

Electrical Industry

27. Electrical Industries have made a fair progress during the last decade and electrical goods such as A. C. and D. C. motors, transformers, switch gears, electric lamps, fans, wires and cables, storage batteries, measuring instruments, etc. are now being manufactured in the country.

ELECTRICAL MACHINERY.

Present position.

28. There are about 23 firms manufacturing electric motors, of which 13 are of some importance. India has an aggregate capacity for production of approximately 1,00,000 H. P. the actual production, however, amounted to about 30,000 H.P. last year.

The important firms engaged in this industry are :—

Southern Zone

(i) Kirloskar Electric Co., Ltd.
(ii) P.S.G. & Sons.
(iii) Charity Industrial Institute
(iv) The Eastern Electric Co., Ltd.

Eastern Zone

(i) The Taylor Electrical Engg. Co.
(ii) Associated Electrical Industries Manufacturing Co., Ltd.,
(iii) Electrical Equipment & Construction Co.
(iv) British India Electric Construction Co., Ltd &
(v) General Electrical Co. (India) Ltd.,

Western Zone.

(i) The Kirloskar Bros.
(ii) The Natioal Electrical Industries, Bombay.
(iii) Jyoti Ltd.
(iv) Crompton & Parkinson Works, Ltd.

Development Plan

29. The present production capacity of the industry is for about 7,500. The panel for this industry has recommended that during the first five-year period, Indian Industry should produce motors and generators numbering 81,000 and during the second five year period 1,44,000 and in the third five-year stage the cuntry should be self-sufficient.

Transformers

30. *Present position.*—Indian Industry has a production capacity for 1,02,000 K. V. A. of transformers but the actual production last year did not amount to more than 30,000 K.V.A. of the 11 firms manufacturing transformers, the following five are important :—

1. Mysore Electrical Industries, Bangalore
2. Crompton Parkinson Works, Bombay
3. Associated Electrical Industries, Calcutta
4. Kaycee Industries Ltd., Bombay and
5. National Electrical Industries, Bombay.

Development Plan

31. The panel has recommended an annual production of 300,000 K.V.A. during the next five year period. It is proposed to produce a large number of transformers between the range of 25,500 K.V.A and up to 11 K.V.A. electric pressure during this period . During the second five year stage the total output is to be doubled and in the third five year stage India should be able to meet all her requirements.

Switch Gears.

32. *Present position.*—Only two firms with a limited production capacity manufacture switch gears in India.

1. The Mysore Electrical Industries, Bangalore.
2. The General Electric Co. (India) Ltd., Calcutta.

33. *Development Plan*—Prior to World War II, the approximate value of the average annual import of switch gears amounted to about Rs. 53 lakhs. The rapid industrialisation programme before us will, however , require considerably larger quantities of this type of equipment. The panel has recommended that India should be able to manufacture switch gears of the value of about Rs. 2 crores per annum during the first five-year period. During the second five-year period—all types of switch gears including circuit breakers should be produced in the country the total value of the products would then amount to approximately Rs. crores per annum.

Electric Lamps.

34. *Present position.*—There are ten concerns in the country manufacturing electric lamps for domestic and train lighting. Of these, seven are in Calcutta, one in U.P., one in Bombay and one in Bangalore. These firms together are capable of producing 13,350,000 lamps a year. The actual production in 1947, however, amounted to only 5,85,000.

35. *Development Plan.*—The pre-war demand for lamps was of the order of 10 millions as against India's present production capacity of 13 millions. The panel has recommended that the country should produce 31 million pieces of all types of lamps a year within the next five years.

36. *Electric Fans.*—There are in the country 43 firms producing electric fans. Only 18 of these can be regarded as manufacturers of first-class product. Of these fourteen are in Calcutta, two in Delhi and two in Bombay. All the firms together have a production capacity of 250,000 fans although in 1947 only about 140,000 were produced.

37. *Cables and Wires .*—With the present arrangements, India should be able to produce 24,350 tons of wires and 50 million yards of cable from the three important firms which are all in the Eastern Zone near Calcutta. In the year 1947, the actual production amounted to only 6,180 tons and 30 million yards respectively. The future demand is estimated to be much in excess to the present production capacity in the country.

Electrical Measuring Instruments

38. There are only four firms in India, which produce electrical measuring instruments but their output is insignificant both in quality and quantity. These are :—

1. The Automatic Electric Devices Co., Bombay
2. Kaycee Industries, Poona
3. Radon House, Calcutta. &
4. Oriental Science Apparatus Workshops, Ambala

The average annual output of measuring instruments during the five years previous to the war was of the order of 100,000 numbers (of approximate value of Rs. 10 lakhs). The post-war demand for these is estimated at 300,000 per year and the Panel has recommended that during the first five year period India should produce 100,000 measuring instruments per year and the production should increase to 300,000 per year during the second five year period.

Storage and Dry Batteries and Electrical Fittings.

39. India has a capacity for the production of 172,000 storge batteries and 132 million dry cells. The actual production last year amounted to only 11,000 and 10 million respectively. Of the seven firms of importance producing these goods, three are in Calcutta and four in Bombay.

40. Electrical accessories such as bakelite and other fittings, conduit pipes, etc. are also produced to some extent.

Government Plan

41. The above briefly represents the picture of the electrical industry as it exists to-day and of the development proposed .

42. It is of interest to note here that the government are considering the establishment of a state-owned factory for the production of heavy electrical manchinery.

43. Unfortunately, only fourteen firms have supplied completeinformation concerning the technical personnel employed by them.

44. These fourteen firms amongst which are five of the most important ones, between them employ the following scientific personnel:

Electrical Engineers	43
Mechanical Engineers	23
Metallurgists	4
Chemists	2
Glass Technologist	1
Physicists	3
Junior Engineers	42
TOTAL	118

The total number of scientific personnel engaged in this industry would not amount to more than 300.

45. Ten of the fourteen firms contemplate expansion of their activities and three of them have stated their requirements for scientific personnel which altogether amount to—

Electrical Engineers	11
Mechanical Engineers	13
Civil Engineers (Hydraulic)	6
Chemical Engineers	6
Radio Engineers	3
Metallurgists	5
Chemists	1
Junior Engineers	4

46. We estimate that to execute the development plan for the five year-period we are likely to require:

Electrical Engineers	200
Mechanical Engineers	150
Mechanical Engineers (Production)	20
Metallurgists	25
Civil Engineers	50
Chemists	15
Physicists	30
Junior Engineers	500

Wireless Equipment

47. At present there are 15 firms producing radio receivers by assembling imported components. Prior to war, India was importing 30,000 radio receiving sets every year. Even if the Broadcasting Station are not increased in number, the demand for receiving sets is sure to increase specially for purposes of spread of adult education. It has been recommended by the Panel that India should produce 400,000 cheap and 100,000 high powered sets every year within the next five years including its components except the radio valves. It is understood that a factory has already been established in Bombay and concrete steps have been taken for the establishment of factories one in Calcutta and the other in Bangalore for the manufacture of components of wireless receiving sets and the production of the sets themselves. At present India has a production capacity of 8,000 radio recievers of which 800 is produced in one factory in Bengal and 1,200 in one factory in Bombay.

48. Three firms have replied to the questionnaire and they employed between them the following :—

Electrical Engineers	3
Radio Engineers	3
Mechanical Engineers	5
Civil Engineer	1
Physicists	1
Metallurgists	1
Chemists	3

49. We estimate our requirements for man-power for the contemplated production of sets and components during the next five year period to be as follows :—

Radio Engineers	150
Physicists	100
Electrical Engineers	100
Mechanical Engineers	100
Metallurgists	20
Chemists	20
Junior Engineers	400

Telegraph and Telephonic Equipment

50. There are three factories other than the P. & T. Workshops, engaged in the production of telephone equipment. These are Messrs. Subhas Services India, India Electric Works, Ltd., Calcutta, and Messrs.Telephone Manufacturers Ltd., Dehra Dun. The major development, however, is taking place in this industry in state-owned factories of the P. & T. Department. Technical Man-power needed has been shown separately under Government Departments

Mathematical & Scientific Instruments.

51. India is almost solely dependent on foreign import for scientific apparatus and equipment. There are one or two important firms, the Andhra Scientific Co.,Ltd., being one worthy of special mention in this connection. This firms manufactures scientific apparatus for physical, chemical and biological laboratories.

52. The Mathematical Instruments Office, which is now under the control of the Ministry of Industry and Supply has probably the best workshop facilities for the production of scientific instruments. It is understood that the M.I.O. Factory is being re-organised in pursuance of the Parajppe Committee's recommendation. During the war this factory produced different kinds of precision instruments—mechanical, electrical, optical, aircraft etc. The factory is capable of producing nearly 20,000 instruments a year of the value of Rs. 8 to 10 lakhs.

53. The Andhra Scientific Co., Ltd., employs

Engineers	2
Chemists	3
Physicists	8
Biologists	3
Geologist	1

Development Plan

54. The requirement for scientific personnel for the proper groath of this industry is estimated to be

Optical Engineers	10
Mechanical & Electrical Engineers	20
Physicists	40
Chemists	10
Metallurgists	10
Biologists	10
Geologists	5
Junior Engineers	80

Industrial Plant and Machinery

55. This industry covers machinery for the textile industry, Mining, Paper, Sugar, Leather and leather goods, Rice and Flour Milling, Oil Crushing and Refining, Wood working, Tea Processing, Printing etc. and agricultural machinery. There are a number of firms engaged in the production of these plants and machinery. Many of them are engaged in the production of other articles such as Machine-Tools, Engines etc. also in addition to the manufacture of industrial machinery. The ten firms who have replied to of the questionnaire together employ

Mechanical Engineers	34
Electrical Engineers	7
Civil Engineers	2
Metallurgists	6
Chemists	7
Junior Engineers	5

56. The average value of the pre-war annual demand for the above type of machinery has been estimated to be Rs. 7·93 crores (Non-textile Rs. 4·69 crores, Textiles Rs. 2·34 crores) on the 1935-36 price index and Rs. 26.23 crores on the 1944-45 price index. The different panels have recommended that India should be able to produce within the next five to ten year period industrial machinery of the value shown below

Mining Machinery	10 crores
Pulp and Paper Machinery	10 "
Sugar Mill Machinery	10 "
Power Alcohol Plant	2 "
Leather Goods Machinery	3 "
Oil Crushing and Refining, Paints, Varnishes & Soap Manufacturing Machinery	3 "
Metal Working Machinery	3 "
Iron & Steel Working Machinery	25 "
Non-ferrous working machinery	2 "
Refractories & Cement Mills working Machinery	7 "
Heavy Chemical Works Machinery	11 "
Rayon Art Silk Machinery	10 "
Ready-made clothing & Hosiery Machinery	10 "
Cotton Textile Machinery	32 "
Woollen Textile Mills Machinery	63 "
Artificial Fertiliser Plant and Machinery	10 "

57. On a very rough estimate we expect that this group of industries would require within the next five to ten years:

Mechanical Engineers	125
Electrical Engineers	50
Civil Engineers	25
Metallurgists	15
Chemists	15
Junior Engineers	400

Light Engineering Industry

58. Under this group we consider industries for the production of such articles as Sewing Machines, Bicycles, Hurricane Lanterns, etc.

Sewing Machines

59. The Jay Engineering Works, Calcutta, is the only important manufacturer in India. The production capacity of this firm is 18,000 machines per year as against India's estimated demand for 100,000 machines.

Bicycles

60. There are three important firms manufacturing bicycles—one in Calcutta, one in Patna and one in Bombay. Their total production capacity is for 62,000 bicycles annually as against the anticipated demand of 300,000.

Hurricane Lanterns

61. There are six large units for the manufacture of lanterns. The aggregate production capacity amounts to about 1 million twenty thousand as against the estimated country's need for 5 million lanterns.

62. We have not been able to secure information concerning production of other articles.

There is, therefore, considerable scope for the expansion of the above group of industries.

63. The Hind Cycles Ltd., Bombay, which is capable of producing 37,500 cycles per year employs.—

Mechanical and electrical engineers	12
Chemist	1
Physicist	1

64. We have not been able to collect information from the other producers. We are, however, of the opinion that for the development of the light engineering industry we shall require during the five to ten year period.—

Mechanical Engineers	50
Electrical Engineers	10
Mechanical (Production) Engineers	10
Chemists	10
Metallurgists	10
Junior Engineers	150

Locomotive and Rolling Stock

65. A fair progress has been made with the manufacture of rolling stocks such as wagons, coaches am-cars, but as yet locomotives are not manufactured in the country. Repair of the locomotives is, wever, carried out in the Railway Workshops.

66. The important private companies manufacturing rolling stock, road rollers, coaches etc. are,—

1. Tata Locomotive & Engineering Co., Ltd.
2. The Indian Standard Wagon Co., Ltd.
3. Jessop & Co., Calcutta.
4. Calcutta Tramways Co,
5. Braithwaite & Co., Calcutta.
6. Burn & Co., Calcutta.
7. Martin & Co., Calcutta.

Of these, three firms have replied to the questionnaire and between them they employ—

Senior Engineers	47
Metallurgists	1
Junior Engineers	185

It should, however, be noted that the firms employing the majority of the engineers are general engineers, producing a variety of products.

The Tata Locomotive and Engineering Co. is expected to turn out in 1948 sixty locomotive boilers, 420 steam road rollers and 500 broad gauge chassis.

67. It is of interest to note that the Government of India has taken the necessary steps for starting a state-owned Locomotive Factory in Mihijam on the border of West Bengal and Bihar. The requirement for technical personnel for this project has been included in the report on the Government and Government-sponsored Departments. The Tata Locomotive and Engineering Co. is also being reorganised and it is expected to produce 100 boilers and 100 complete locomotives every year. The next five-ten years' requirements of technical personnel in this industry are estimated to be—

Mechanical Engineers	30
Electrical Engineers	20
Civil & Structural Engineers	20
Junior Engineers	100
Metallurgists	10
Fuel Technologists	10
Chemists	10

Ship Building

68. At present there are in India six firms capable of undertaking new construction—three in Calcutta two in Bombay and one in Vizagapatam and the present production capacity is estimated to be 25,000 gross tons per year. The largest ship built in India is a 8,000 tons sea going vessel which was built by Messrs. Scindia Ship Yard, Vizag. The other ship builders are primarily engaged in the repair of sea-going vessels and manufacture of inland watercrafts of less than 1,000 tons-gross. Four of these firms including the Scindia Co. have replied to the questionnaire ; it is now learnt that between them they employ—

Civil Engineers	4
Naval Architects & Marine Egineers	36
Mechanical Engineers	46
Electrical Engineers	7
General Engineers	13
Junior Engineers	23

Development Plans

69. The Hooghly Docking and Engineering Co., Ltd. of Calcutta and Messrs. Scindia Ship Yard are contemplating expansion. The Scindias propose to increase their total tonnage to 80,000 tons per year. It has been estimated that India should have 2 million gross tons of shipping within the next five years either by increasing the capacity of the existing yards or by constructing new ones.

70. We estimate that to attain the target of production within the next five to ten year period we would require—

Mechanical Engineers	100
Electrical Engineers	30
Civil Engineers	50
Marine Engineers	80
Naval Architects	30
Junior Engineers	400

Automobiles and Tractors

71. Within the last few years two automobile companies were registered in India for the manufacture of automobiles—the Hindustan Motors Ltd., Calcutta and the Premier Automobiles Ltd., Bombay. Neither of thsse companies, however, has actually started the production of complete automobilies. The Hindustan Motors Ltd., hope to produce only some of the components in the near future. In addition to the above, there are five works for the complete assembly of cars and trucks. The distribution of these works is as follows :—

Four in the Western Zone,

One in the Southern Zone, and

Two in the Eastern Zone.

The Hindustan Motor's Plant at Okha employs a technical staff of 60.

Development Plan

72. In the pre-war period, India was importing about 12,000 motor cars and 10,000 trucks. The Panel on Automobile and Tractors' have expressed the opinion that the annual demand is likely to be of the order of 45,000 vehicles and India should be able to produce this number. It is estimated that the following technical personnel will be required for the automobile industry, for the next 5 years.

Automobile Engineers including Designers	100
Mechanical Engineers (Production Engineers)	25
Mechanical Engineers (General)	50
Electrical Engineers	25
Metallurgists	10
Chemists	10
Junior Engineers	300

73. The country does not produce any tractors and the Panel has not been able to recommend definite figures for the production. There is little doubt that this industry should be set up for the development of mechanised agriculture and also for future defence requirements.

Aircraft Industry

74. There is only one plant, namely, the Hindustan Aircraft Ltd., Bangalore, capable of producing aircrafts. The engine units and instruments cannot, however, be produced in this factory. It was started in 1941 and almost right from the beginning its main activity has been directed towards repair and overhaul of aircraft including aero-engines. It is expected that in the near future this firm will engage itself in the manufacture of complete aircrafts for the requirements of the R.I.A.F. and civil aviation.

75. A number of small maintenance workshops also exist in the major airports for the day to day servicing of the civil aeroplanes.

76. The Hindustan aircraft Ltd. employs the following technical personnel :

Aeronautical Engineers	32
Mechanical Engineers	9
Electrical Engineers	4
Civil Engineers	4
Radio Engineers	1
Engineers (unclassified)	19
Chemists	6
	75

77. While it is difficult to give an idea of the scientific manpower that will be required by the Hindustan Aircraft Ltd. to manufacture a substantial portion of the aircrafts for civil and defence requirements, we, even on a conservative estimate, consider that at least the following additional personnel would be required within the next five to ten year period.

Aeronautical Engineers	100
Mechanical Engineers	40
Electrical Engineers	20
Radio Engineers	20
Civil Engineers	20
Production Engineers (Mechanical)	20
Chemists	10
Metallurgists	20
Junior Engineers	300

Electrical Power Generation, Transmission and Distribution.

78. There are mainly two types of electric supply undertakings in this country—

(*i*) those that generate their own power and then distribute ; they number 402 of which 66 are steam plants, 20 hydroplants and 316 oil plants ;

(*ii*) those that buy bulk supply from a neighbouring generating station and then re-distribute the same either through transformation or directly to the consumer ; they number 135.

Installed Capacity of the Generating Plants as on 31-12-1944

79. Total installed capacity of each of the three types of Generating Plants, stated above is—

(*a*) Steam Plant	682,936 K.W.
(*b*) Hydro Plant	479,019 K.W.
(*c*) Oil Plant	118,029 K.W.

and the corresponding million K.W. hours of energy generated during the year were

(*a*) 1,632,536 million K.W.H.

(*b*) 2,053,258 million K.W.H.

(*c*) 155,518 million K.W.H.

80. The size of the plants may be seen from the following table.

	Steam Plant	Oil Plant	Hydro Plant
Upto 250 K.W.	12	193	2
251 to 500 K.W.	10	80	2
501 to 750 K.W.	4	20	..
751 to 1,000 K.W.	3	6	1
1,001 to 5,000 K.W.	21	16	6
5,001 to 10,000 K.W.	5	1	1
10,001 to 50,000 K.W.	10	..	6
50,001 to 100,000 K.W.	..	..	1
Over 100,000 K.W.	..	..	1

81. Replies have been received from 31 stations as shown below :

	Stations.	Installed capacity in K.W.H.
Northern Zone	2	12,430
Southern Zone	3	62,570
Eastern Zone	9	66,631
Western Zone	17	282,418

and the technical personnel employed therein are

Northern Zone.—	
Electrical Engineers	11
Mechanical Engineer	1
Foreman	1
Southern Zone—	
Electrical Engineer	10
Mechanical Engineer	Nil
Foreman	,,
Eastern Zone—	
Electrical Engineers	23
Mechanical Engineers	6
Foremen	2
Chemist	1
Western Zone—	
Electrical Engineers	164
Mechanical Engineers	12
Sales Engineers	2
Hydraulic Engineers.	10
Civil Engineers	3
Elect. & Mech. Engineer	1
Chemists	2
Foremen	3
Engineers Asst. & Cadets	8

82. Thus altogether in these 31 power stations the following technical personnel are employed—

Electrical Engineers	208
Mechanical Engineers	19
Sales Engineers	2
Hydraulic Engineers.	10
Civil Engineers	3
Elect. & Mech. Engineer	1
Chemists	3
Foremen	6
Engineers Asst. & Cadets	8

Development Projects.

83. Development of industries is indissolubly linked with the development of electrical generation projects. New thermal and hydraulic stations will have to be erected. The Provincial and Central Governments are well alive to their responsibilities as will be seen from the tabulated statement on new projects of irrigation and water power devolepment. In the following table prepared by the Electrical Commissioner will be seen a picture of the development that is likely to take place within the next 15 years or so :—

All figures in Megawatts.

Type of Plant	*1939*	*1946*	*1953*	*1958*	*1964*	*1963*
Steam Electric	573,063	775,186	11,575,43	16,75,000		18,90,000
Percentage increase in 1939 figure	..	35%	154%	192%		230%
Hydro-electric	450,769	507,219	11,33,536	14,70,000		18,10,000
Percentage increase in 1939 figure	..	12%	147%	226%		300%
Diesel Electric	112,243	121,525	1,34,585	1,41,200		1,48,000
Percentage increase on 1939 figures	..	7%	20%	26%		32%
TOTAL	11,36,075	14,03,930	27,25,664	32,86,200		38,48,000
Percentage increase on 1935 figures	..	24%	145%	194%		245%

84. The type of technical personnel required to effect the development and their number would largely depend on the sizes of the new generating stations, areas over which they would distribute energy and also on the kind of generating plants installed. Assuming that the hydro-electric development will take place mainly under the auspices of the Government, some of whom have indicated their requirement for technical personnel, which have been taken note of elsewhere in the Report, the following technical personnel are likely to be required on a Conservative estimate to effect mainly the development of the thormal power generation industry.

	1953	1958	1963
Electrical Engineers	1,200	1,500	1,800
Mechanical Engineers	400	500	600
Civil Engineers	200	250	300
Junior Engineers	400	500	600
Fuel Technologists	60	70	90
Chemists	40	50	60

Constructional Work

85. Most of the constructional work connected with civil engineering is carried out by private firms who undertake this work on contract basis. There are in India a large number of such firms, some of whom employ a large number of engineers and overseers, mainly civil engineers, while others executing construction of small residential buildings do not employ any qualified engineers. Apart from the large amount of constructional work involved in the many Government projects, a substantial amount similar of work is involved in the construction of private buildings, the private building activities having perforce had to remain for all purposes suspended during the last 8 or 9 years.

86. We anticipate that Civil Engineers numbering 400 and overseers 1,200 (*i.e.* about 25% of the number required by Government and manufacturing industry) would be engaged in this activity during the next 5—10 year period.

Summary Statement of the assessment of personnel for Industrial Development and the number of persons who will have to be sent abroad for higher training.

CATEGORY	Senior Personnel (Graduates in Engineering, Technology, Medicine etc.; Post-Graduates in Pure Sciences)	Junior Personnel (Diploma holders in Engineering, Technology, Medicine etc.; Graduates in Pure Sciences)
A. Heavy Chemical Industries.		
Chemists and Chemical Technologists.		
Inorganic and General Chemists	378	
Physical Chemists	242	
Electro Chemists	70	720
Organic Chemists	24	
Metallurgy Chemists with special knowledge of Electro-Metallurgy	6	
ENGINEERS		
Chemical Engineers	160	
Mechanical Engineers	148	
Electrical Engineers	40	360
Electrical Engineers with special knowledge of Electro-Thermics	7	
Fuel & Furnace Technologists	5	

B. Drugs and Pharmaceuticals

Chemists—

Organic Chemists	108	
Bio Chemists	23	
Inorganic Chemists	8	
Physical Chemists	10	
Electro Chemists	2	188
Mycologists	2	
Bacteriologist	1	
Pharmacologist	2	
Assayists (Chemical)	30	
Assayists (Biological)	30	

ENGINEERS

Mechanical Engineer	1	
Electrical Engineer	1	28
Chemical Engineers	11	

C. Soaps, Oils and Facts

Chemists and Chemical Technologists in Soaps, Oils and Facts	252	432

ENGINEERS

General Mechanical or Elec. Engineers	94	94

D. Essential Oils.

Chemists—

Organic Chemists and Chemical Technologists	30	

E. Paints and Varnishes.

Chemical Technologists in Paints, Enamels and Varnishes	80	
Chemists or Chemical Technologists with specialised training in the manufacture of inorganic pigments	10	
Fuel and Furance Technologists	4	90
Organic and/or Physical Chemists with specialised training in the manufacture of synthetic resins and resins from natural products	10	
General Mechanical or Chemical Engineers	40	100

F. Plastics.

Plastics Chemists or Chemical Technologists in Plastics	50	140
Physicists	5	
General Mechanical Engineers	10	90
Chemical Engineers	20	

G. Sugar, Fermentation & Foodyeast Industry

Chemists—

Chemical Technologists in sugar manufacture	88	
Fermentation Technologists	29	146
Biochemists or Fermentation Technologists with specialised training in the manufacture of Foodyeast	20	

OTHER CATEGORIES.

Microbiologists or Bacteriologists	10	

Engineers—

General Mechanical Engineers	88	135
Chemical Engineers	39	

H. Paper, Boards and Chemical Cotton.

Chemists and Chemical Technologists in paper manufacture	110	118
Chemists or Chemical Technologists with specialised training in cellulose technology	8	
General Mechanical and Electrical Engineers	91	93
Chemical Engineers	4	

I. Cement.

Chemists and Chemical Technologists	88	87
General Mechanical and Electrical Engineers	219	219
Geologists	15	

J. Metallurgical Industries.

Ferrous—

Chemists	280	
Fuel Technologists	80	
Ceramics and Refractory Technologists	30	
Metallurgists & metallurgical Engineers	420	100
Geologists	30	
Physicists	2	

Engineers.—		
Mining Engineers	100	
Electrical Engineers	300	
Mechanical Engineers	200	
Civil Engineers	30	200
Chemical Engineers	6	
Miscellaneous Engineers	80	
Docotors	180	
Non-Ferrous.—		
Metallurgists and Metallurgical Engineers	75	
General and Inorganic Chemists	10	
Fuel Technologists	10	50
Electrical Engineers with specialised training in Electro-Thermics	5	
General Mechanical and Electrical Engineers	30	
K. Mining.		
Engineers.—		
Mining Engineers	200	200
Mechanical Engineers	50	100
Electrical Engineers	50	100
General Inorganic Chemists	50	50
Geologists	50	100
L. Fuel Industry.		
Fuel Technologists	50	
Mechanical Engineers	25	
Electrical Engineers	25	100
Chemical Engineers	20	
Organic Chemists	50	
Physical Chemists	25	
M. Textile.		
Cotton Textiles.—		
Textile Technologists	450	563
Textile Chemists	160	203
Engineers - Mechanical, Electrical & Textile	300	373
Silk.—		
Silk	Nil.	
Rayon.		
Engineers - Mechanical, Electrical and Chemical	21	105
Chemists and Chemical Technologists (Cellulose)	56	105
Textile Technologists (Rayon)	28	
Woollen.—		
Textile Technologists	86	150
Chemists	57	50
Engineers	57	112
Subsidiary Industries.		
Engineers	225	225
M. Glass Industry.		
Glass Technologists and Chemical Technologists	180	225
Fuel and Furnace Technologists	25	
General Mechanical Engineers with specialised knowledge of automatic or semi-automatic machinery for use in glass industry	60	100
N. Ceramics.		
Ceramists	97	110
Chemists & Chemical Technologists	50	60
Electrical Engineers	40	
Mechanical Engineers	28	130
Fuel Technologists	10	
Geologists	5	
Mining Engineers	5	
O. Leather and Leather Goods.		
Leather Technologists including specialists in footwear manufacture	250	400
Leather Chemists	50	100
Engineers	Nil.	

P. ENGINEERING INDUSTRIES.

(a) *Prime Movers.*

Mechanical Engineers	200	450
Electrical Engineers	40	
Metallurgists	20	
Fuel Technologists	20	
Chemists	10	

(b) *Machine Tools.*

Metallurgists (Ferrous, Non- errous and Heat treatment)	20	450
Mechanical Engineers (Machine-tool designers)	25	
Mechanical Engineers (Production Engineers)	25	
Mechanical Engineers (General)	120	
Electrical Engineers	35	
Civil Engineers	10	
Chemists	15	

(c) *Cutting Tools.*

Metallurgists	10	60
Mechanical Engineers (machine-tool experts)	20	
Electrical Engineers	10	

(d) *Hand Tools and Agricultural Implements.*

Nil.

(e) *Wire and Wire Products.*

Nil.

(f) *Steel Fabrication and General Engineering.*

Civil Engineers	100	600
Mechanical Engineers	60	
Electrical Engineers	20	
Matallurgists	20	

(g) *Miscellaneous Engineering Industry.*

Civil Engineers	80	600
Mechanical Engineers	150	
Electrical Engineers	150	

(h) *Electrical Industry.*

Electrical Engineers	200	500
Mechanical Engineers	150	
Mechanical Engineers (Production)	20	
Civil Engineers	50	
Metallurgists	25	
Chemists	15	
Physicists	30	

(i) *Electronics.*

Radio Engineers	150	400
Electrical Engineers	100	
Mechanical Engineers	100	
Physicists	100	
Metallurgists	20	
Chemists	20	

(j) *Scientific Instruments.*

Optical Engineers	10	80
Mechanical and Electrical Engineers	20	
Physicists	40	
Chemists	10	
Metallurgists	10	
Biologists	10	
Geologists	5	

(k) *Industrial Plant and Machinery.*

Mechanical Engineers	125	400
Electrical Engineers	50	
Civil Engineers	25	
Metallurgists	15	
Chemists	15	

(*l*) *Light Engineering Industry.*

Mechanical Engineers	50	
Electrical Engineers	10	
Mechanical Engineers (Production)	10	150
Chemists	10	
Metallurgists	10	

(*m*) *Locomotive and Rolling-stock.*

Mechanical Engineers	30	
Electrical Engineers	20	
Civil and Structural Engineers	20	100
Metallurgists	10	
Fuel Technologists	10	
Chemists	10	

(*n*) *Ship-building.*

Mechanical Engineers	100	
Electrical Engineers	30	
Civil Engineers	50	400
Marine Engineers	80	
Naval Architects	30	

(*o*) *Automobile and Tractors.*

Automobile Engineers including designers	100	
Mechanical Engineers (Production Engineers)	25	
Mechanical Engineers (General)	50	300
Electrical Engineers	25	
Metallurgists	10	
Chemists	10	

(*p*) *Aircraft Industry.*

Aeronautical Engineers	100	
Mechanical Engineers	40	
Electrical Engineers	20	
Radio Engineers	20	300
Civil Engineers	20	
Mechanical Engineers (Production)	20	
Chemists	10	
Metallurgists	20	

(*q*) *Electrical Power Generation, Transmission & Distribution.*

Electrical Engineers	1200	
Mechanical Engineers	400	
Civil Engineers	200	400
Fuel Technologists	60	
Chemists	40	

(*r*) *Constructional Work.*

Civil Engineers	400	1200

GOVERNMENT OF INDIA

MINISTRY OF EDUCATION

REPORT OF THE SCIENTIFIC MAN-POWER COMMITTEE

(SURVEY AND ASSESSMENT)

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GOVERNMENT AND GOVERNMENT SPONSORED DEPARTMENTS

1. We shall now deal with the scientific and technical activities of the Central, Provincial and Indian States Governments and Government sponsored departments, and estimate their requirements for scientific and technical personnel during the next five and ten year periods. We should mention here that subjects, such as defence, communication including rail transport and broadcasting are almost entirely managed by the Central Government.

2. We consider below under a particular head the similar field of activity of all Governments together. For instance, all public health activities comprising establishmment and maintenance of health units, manufacture and distribution of vaccine and sera, training of public health officers, sanitary inspectors, health visitors nutrition surveys, etc. are under one head. Similarly, construction of roads, bridges, buildings, planning and execution of irrigation projects and other civil engineering activities come under Public Works. Soil survey, seed multiplication and distribution, plant protection and quarantine, distribution of agricultural implements and manure, development of improved varieties of food crops and other agricultural activities are grouped under agriculture. The activities connected with general industrial development, participation of certain Governments in particular industries, etc. are covered under Industry and Civil Supplies.

3. Detailed analytical statements on the various departments of the Government are given in Apppendix——————————. These indicate the field and scope of their activities, technical staff employed, annual intake into various categories, training facilities available, development plans, requirements for staff and equipment, views of the heads of departments on drift or leakage, standardization of training, status of scientific workers, need of training of Indian personnel abroad and new lines of manufacture which should be undertaken in the country with a view to self sufficiency.

COMMUNICATIONS

Post and Telegraph Department

4. The Department maintains the postal, telegraph and telephone services of the country. In 1939* the telegraph and telephone net work in India consisted of about 100,000 miles of over-head lines consisting of 500,000 miles of wire operating 11-Three-channel carrier telephone systems and 7-single-channel carrier telephone systems. From this net work about 10,000 large and small telegraph offices and 600 small telephone exchanges and local system operated by licenced companies were served.

Recent Development

5. During war-time an intensive development programme was undertaken in collaboration with the Army authorities. This included construction of new main over-head lines containing 9,500* miles of post route and carrying 144,000 miles of wire, installation of 123, three-channel carrier telephone system on the main net work ; installation of fifty two, six, twelve and eighteen-channel "voice frequency" telegraph system, manufacture and installation of 400 trunk exchanges and local net work of underground cable (1050 miles). In addition large programme of subsidiary works for providing local communication for services commands, air fields, military camps, and addition to subscribers' lines was undertaken.

Staff Employed

6. The technical staff employed consists of graduates in Engineering, graduates in Science and Intermediate Science. The staff at present consists of 175 class I officers 356 Class II officers and 1,100 non-gazatted officers. The bulk of the Class I Officers are graduates in Engineering or possess equivalent Engineering qualification. Recruitment to Class I is based on this qualification except in the case of Class II officers who have generally passed intermediate stage in their service or are graduates in Science. There is no direct recruitment to Class II. During the war 26 Class I and 1,398 non-gazetted officers were recruited. All these offices will be absorbed in the department in view of the post-war development plans.

Figures obtained from an artical by N. F. Forme Esqr; published in the Journal of the Institution of Electrical Engineers, Part I, January, 1948.

Development Programme

7. Based on the experience of war time development, an expansion and improvement plan for tele-communication system is envisaged during the next period of 15 years. It covers expansion of secondary lines of net work, installation of tele-printers, conversion of existing telephone exchanges to automatic system and installation of a large number of new automatic exchanges. It is understood that the Department is negotiating with a foreign firm to undertake the manufacture of automatic telephone equipment in the country. It is likely that work may start in about 2 years' time.

8. The work of expansion and improvement of service will be completed in 3 periods of 5 years each, Total capital expenditure has been estimated to be Rs. 39·02 crores and total recurring at Rs. 60·01 crores.

9. With regard to the postal department the new developments contemplated relate to introduction of labour saving devices for stamping letters, departmental management and maintenance of mail vans, vacuum cleaning devices for mail clearing bags, R.M.S. van apparatus for exchanging ponches and tansforma bundling and Sealing machines.

Staff Requirements

10. It may be stated that the entire development plan is to be taken in sections approved by the Government due consideration being to the availability of finance, and it is also anticipated that in no year abnormal recruitment would take place. The existing staff (Pre-war permanent and that recruited in war-time) in the cadre of Gazetted Officers, together with the normal replacement will be able to complete the development programme which has already been taken in hand. Only in the case of non-gazatted officers fresh recruitment will be required at the rate of 200 per year. The annual intake due to retirement and wastage of officers has been estimated at 9 officers per year. The total for the next five years will therefore be 45 gazetted and 100 non-gazetted officers.

11. So far as improvements in the postal department are concerned, it has to be observed that the Department is contemplating establishment of a cadre of technicians to look after the maintenance of the mechanical units that will be installed. The details of these have not been worked out yet but the installation of these devices at Delhi, Calcutta, Bombay and Madras will require the services of at least one mechanical engineer and six mechanics who are diploma holders (2 electrical and 4 mechanical) at each of these places. Further, it may be assumed that during the next period of 5 years, this modernization in the Post-Offices will take place although the proposals have not been finalised to far. Total requirements of the cadre of technicians will, therefore, be of the order of 28 [4 Mechanical Engineer (Grad-nates) 8 Electrical Engineers—Diploma holders, and 16 Mechanical Engineers Diploma holders].

12. It has not been possible to estimate the staff requirements for the proposed factory to manufacture automatic equipment. In the initial stages at least, it is anticipated, that foreign experts will come to India under the terms of contract and the requisite Indian staff will be drafted from the department. The services of a chemist and a metallurgist may, however, be needed.

Pattern of Employment

13. Engineering graduates in Tele-communication, Electrical or Mechanical Engineering are required for Class I cadre and such men who have passed intermediate examination in Science and hold diploma in Engineering are required for the non-gazetted posts. The total requirement of the department of this basis comes to :—

Engineering Graduates	45
Engineering Diploma holders	500
Intermediate Science and above	500
Chemist	1
Metallurgist	1
TOTAL	1,047

Training Facilities

14. Normally the Post and Telegraph Department manufacture their line stores at their Calcutta factory. A few items such as porcelain insulators and line wires are obtained from well established concerns in India. To meet expanded war requirements another factory was established at Jubbulpore. The workshops of the licensed companies at Bombay, Calcutta and Madras were taken over by the Post and Telegraph Department and were expanded and equipped to undertake manufacture of 250 trunk exchange switch boards with their complement of auxiliary instruments such as relays. The training of personnel was mostly carried out at their Jubbulpore factory. The training facilities available are of a specialized nature and normally are not required by other departments. The facilities are, therefore, made available only to department staff.

15. The department normally make its own arrangements for the foreign training of its staff. In 1947, 3 officers were deputed to the British Post Office and proposals are being considered departmentally to depute more staff.

16. It may be pointed out here that the department's workshop at Jubbulpore is well equipped for the manufacture of stores required for the department and can offer good training facilities for the manufacture of scientific instruments. We suggest that the facilities may be made available to non-employees also and that at least 40 men per year, over and above the normal departmental needs, may be trained in Tele-communication engineering and manufacture of instruments.

India Meteorological Department

17. The primary function of the Department is to give short-range, medium-range, and long-range weather reports and forecasts to aviation and shipping services, and to such department as Agriculture, Irrigation, Medical and Public Health, Public Works, Railways, Forests, etc. They prepare daily, weekly, monthly and annual summaries of various meteorologial elements and compile climatological data of the country. In addition scientific investigations are conducted on radiations, atmospherics, seismology, solar physics and astrophysics, meteorology and its various branches, geophysics, terrestrial magnetism and earth currents.

Recent Developments

18. A considerable expansion of the Department took place in 1942 to bring the Department to an efficient level, especially, to meet war needs. The expansion was so planned as to be able to meet the post-war needs of other departments such as civil aviation, agriculture and shipping with a minimum alteration during the transition period. The Central Office at New Delhi, now controls the Weather Station at Poona, 13 Regional Forecast Centres of Type A,B and C, 10 Auxiliary Centres, 10 Radiosonde Stations, 47 Pilot Balloon Stations, 24 Aerodrome Reporting Stations, 7 Current weather Reporting Stations and 225 Surface Observatories.

Staff Employed

19. Only 90 gazetted officers and 369 non-gazetted officers have furnished their particulars to the Central Office. Further information is awaited. The sanctioned staff amounts to about 150 officers and 1,450 non-gazetted officers. The basic qualifications for fresh entrants to this service is a good degree in Physics/Mathematics/Physical/Chemistry/General Sciences. Necessary training in Meteorology is subsequently imparted by the department itself.

Development Programme

20. The development plans of the Department have been drawn up to meet the civil requirements and the basic requirements of the defence forces. The recent Convention of International Civil Aviation held at Chicago in 1944, to which India is a signatory, has laid down higher standards for observational and forecasting organizations. The revised standards have to be put into practice so that the needs of the development of International Aviation and Internal Civil Aviation can be met. To fulfil these obligations it is necessary to set up a total of 30 Forecasting

Centres of Types A_p, A, B, C, 25 Auxiliary Centres, 16 Radiosonde Stations, 4 Stations for finding direction of Atmospherics, 3 Stations for finding direction of wind by radio, 57 Pilot Balloon Stations, 92 Aerodrome Reporting Stations, 40 Current Weather Observation Stations and 323 Surface Observatories. These are considered to be the minimum requirements. The main tele-communication channels for the meteorological services will have to be tele-printer lines and the radio stations set up during the war time will be used for broadcasting regional messages for meteorological services of India and neighbouring countries. Office and residential accommodation will also be necessary for the new units.

21. The research activities relating to the following have to be expanded and developed :—

Upper air observations ; medium Range forecasts ; agricultural meteorology (weather forecast for farmers, crop Weather Scheme, and Phenological Scheme) co-relation of data on melting of glaciers, snow falls, rain on catchment areas, su bsoil water etc. with heavy rains and floods ; collection of data relating to marine meteorology and gli ding meteorology, weather studies in India and abroad ; structure of atmosphere, study of clouds, electric fields of thunder clouds and other allied investigations.

22. It is also considered necessary to establish a number of special research institutions such as :—

(1) Central Seismological Institute and 12 Observation Stations for research and development of Seismology.

(2) Central Geophysics Institute for work on geodesy, seismology, terrestrial magnetism and earth currents, geophysical prospecting etc.

(3) Astrophysics Research Institute and Observatory.

23. On account of extreme pressure of urgent work during the last few years the normal task of compilation and preparation of Year Books, Atlas, etc. has fallen into arrears. It is necessary that the outstanding arrears should be cleared at an early date.

Staff Requirements

24. The departmental staff requirements may be considered under

(a) normal replacements and (b) development programme including expansion of research activities.

Five year's requirement on account of wastage, retirements etc. has been estimated as 25 officers and 150 non-gazetted officers. These estimates are based on average annual intake. There may be abnormal intake in the current year due to the partition of the country.

25. For the establishment of new units it has been estimated that 25 additional officers and 150 non-gazetted officers will be needed. (1945 estimates).

26. Two Committees were appointed to advise on the establishment of a Central Geophysical Institute and the Astrophysics Research Institute. The former Institute will be for teaching and research and will need a staff of :

Director	1
Professors	6
Lecturers	12
Senior Scientific officers	4
Junior Scientific officers	6
Scientific Assistants	17
	46

27. It has been recommended that the proposed Astrophysical Research Institute be established by expanding and enlarging the Kodai-Kanal Observatory. Additional staff requirements are :—

Officers	10	all Physicists.
Non-Gazetted Officers	26	

28. Requirements for the proposed Central Seismological Institute have not been stated. It may be presumed that the necessary staff will be recruited from amongst the trained and experienced hands of the department.

29. For the classification of accumulated data it is felt necessary to recruit 7 officers and 44 non-gazetted officers (Metesrologists).

30. The total requirements thus are :—

	Officers	N.G.O.
Meteorologists	57	344
Staff for Research Institutes (Physicists, Chemists, Geologists, Geophysicists, etc.)	39	43
	96	387

Pattern of employment

31. As had been mentioned earlier, the department mostly recruits graduates in Physics, Physica Chemistry, Methematics and General Science. Keeping in view the proportion of these categories already employed, we may classify the requirements as :—

	Senior	Junior
Physicists	35	214
Chemists	10	70
Mathematicians & Statisticians	12	60
	57	344

(The number of officers in various categories has been fixed, the proportion of officers and non-gazetted officers as stated above being duly considered and is, generally speaking 1/6th of staff in the latter category.)

32. The staff of the Astrophysical Research Institutes will consist of Physicists, whereas that of the Central Geophysical Institute will consist of Geologists, Geophysicists, Physicists and Mathematicians. The precise proportions of these, however, have not been stated but it may be assumed that their requirements will be in the ratio of 4:2:1. On this basis the requirements of the Research Institute may be classified as :—

Geologists & Geophysicists	26
Physicists	50
Mathematicians	6
	82

Training Facilities

33. The department makes arrangements for the training of their staff at the Meteorological Training Centre for training in theoretical and practical meteorology and at the Meteorological Communication Centre at Bombay for practical training in use of Tele-printers. Operators and supervisors are given specialized training at various forecast centres, observatories etc. At present the training arrangements are stated to be quite adequate, but in view of the necessity of training large numbers of personnel in various categories, we feel that training facilities should be increased correspondingly. The 89 officers which the department needs will have to undergo exhaustive training in various subjects.

34. For their normal requirements it is not necessary to depute staff to foreign countries, but foreign training will be necessary in the following branches :—

Synoptic Meteorology, application of radio and radar technique to Meteorology, Geophysics, Astronomy, Astrophysics.

It has been suggested that two officers per year may be deputed.

The establishment of the proposed research Institute for Geophysics and Astrophysics will provide additional facilities for the training of staff and will make the country self-sufficient in these branches.

35. The armed forces also require the services of trained meteorologists for the specialized need of the Royal Indian Air Force. They have no special establishment to cater for these requirements but normally obtain the desired information from the Meteorological Department. The internal civil air

lines also require the services of trained meteorologists. It has not been possible to assess these requirements as their development is governed by many other factors. To meet these needs the department will be able to make arrangements for the practical training of 50 ou side students annually, but some increase in the teaching staff will be necessary. This trained personnel, it is hoped, will be employed in civilian capacities and will form a good reserve for the air force to draw on in case of an emergency.

Civil Aviation Department

36. The operation, maintenance and planned expansion of internal air transport service is a primary function under modern conditions for a balanced social, economic and industrial development of the country. Here this department plays an important part.

Recent Development

37. With the declaration of war the international air services touching India were considerably reduced, and the internal services were adapted to meet war needs and the activities of the department increased correspondingly. Its main functions can be grouped under three heads :—Airways, aircraft operations, and works. Each division covers subject which are closely inter-related. *Airways* division is responsible for the entire ground organization for aircraft operation *viz.* equipment, flying operations and maintenance, aerodrome organization, radio service and liaison with the Director General of Observatories for meteorological services. The branches dealing with international relations legislation, framing of rules and other allied work are also attached to this division.

38. Activities relating to operation, testing and certifying air-worthiness of aircraft are grouped under the *Aircraft* division. Commercial use of aviation and its development also comes under this division. Broadly speaking subjects dealt are : training and licencing of personnel, aeronautical inspection, investigation and analysis of accidents etc. A noteworthy development is the establishment of a research division for keeping pace with Current developments and handling such problems as arise in the day-to-day work. From this small beginning it is hoped that a suitable organization will be built up to undertake design and tender advice on production.

39. The execution of works, it has been decided, is to be the responsibility of a section of the Central Public Works Department attached to this Directorate.

Staff Employed

40. Staff employed in the various divisions at present numbers 331 officers and 8 non-gazetted officers. The basic qualifications of the staff are those of engineers physicists, mathematicians or general science graduates but a large number of the staff has to be trained subsequently for the specialized needs of the Department. A number of posts — 120 for officers and 37 for non-gazetted officers—are vacant as suitably qualified and experienced persons are not easily available. It is hoped that these vacancies will be filled up during the next five years.

Development Programme.

41. The development plans for the next five and ten years periods envisage construction of aerodromes, organization of air route services (both internal and external) aeronautical radio service, expansion and reorganization of the Headquarter organization and making adequate arrangements for aeronautical training and education in the country. To achieve these plans it is proposed to establish training schools for aerodrome officers, ground engineers and pilots and develop flying clubs through Government initiative. The air transport branch is to be expanded in the light of international and internal agreements and 100 aerodromes with full flying control are to be provided during the next five years. This number is to be increased to 150 during the next 10 years. The Inspectorate Directorate is to be expanded as may be necessary due to developments in aircraft manufacture and expansion of air transport services. It may also be mentioned here that the department is contemplating the establishment of an Aeronautical Research Laboratory to undertake basic and applied research on problems relating to aviation. A start in this direction has already been made by the establishment of a research and development division in the central organization. Arrangements are being made to provide the necessary laboratory facilities.

42. For the Development plan the Civil Aviation Department needs various categories of personnel—tele-communication & electrical engineers, aeronautical engineers, Physicists etc. A large number of specially trained personnel with experience of flying, aircraft mechanics, etc. are also required. In the following Statement are indicated the requirements for Scientific & Technical personnel for the next 5—10 year period. Only those who are required to possess academic qualifications in addition to practical experience are included :—

Category	No.	
Aerodrome Officers—Graduates in arts Science with flying experience	218	
Airfield Supervisors—Diploma holders in civil engineering	45	
Tele-Communication Electrical Engineers Graduates and post graduates	100	
Radio operators & technicians—Diploma holders in Radio Engineering	557	
Ground Engineers—Diploma holders in Mechanical Engineering with practical experience preferred	23	
Instructor in Air Navigation—Graduates in Mathematics preferred.	1	
Instructor in flying control systems—Science graduate	1	
Instructor in Meteorology and Meteorological Assistants—Physicists	3	
Medical Officers	2	
Foremen.—Diploma holder in Automobile or Mechanical Engineerin	1	
Air-craft Examiners—Personnel with degree or diploma in Mechangica /ctrical Engineering preferred	105	
Aeronautical Engineers—Graduates & post-graduates	For Research & Development	26
Physicists post-graduates		44
Engineers—Unclassified—Graduates & post-graduates		12
Miscellaneous Technical personnel—graduates in Science		10

Training Facilities

43. The department is running a training school at Saharanpur for the training of radio technicians and radar operators. The school can take about 250 operators and the course of training extends over a few weeks. Proposals have been made to provide training facilities for 'B' class licensed pilots, aerodrome control operators, ground engineers, navigators, etc. The staff employed on teaching work in this school has already been taken into consideration. A similar school with accommodation for a limited number of trainees was being run at Karachi Airport but it has now been handed over to the Pakistan Government. No training facilities are available in the country for advanced training in flying control, navigation, inspection and certification, training of pilot instructors, advanced aeronautical engineering, radar aids and air transport designs. The department feels that it is necessary to send students abroad to obtain requisite training in various subjects. The number suggested is 38 in first year and 31 in the second year and 19 in each subsequent year. Five years' requirements on this basis come up to about 166 students. It is therefore obvious that we must start training courses in the subjects in which facilities are not at present available in Indian Institutes and Universities. The training facilities available in the department are for the use of employees and not for outsiders. The department, also, conducts suitable examination for award of certain certificates after the candidates have served the necessary period of apprenticeship with a recognized air line.

44. We would like to point out that as adequate training facilities in various subjects are not available in other institutions, the commercial airlines have felt the lack of suitably qualified staff. The task of providing suitable opportunities for training the staff of the commercial airlines, therefore, rests on this department. We have not been able to obtain any information on the future development of the commercial airlines but this will be governed in no small measure but two factors, namely, availability of trained personnel and manufacture of aircraft in the country.

45. We would also stress here that in times of emergency the civil aviation personnel can, to a very large extent, meet the immediate requirements of the Air Force. From the defence point of view, therefore, it would be very desirable to create a reserve of such personnel normally employed as civilians in various commercial concerns so that they could be absorbed by the defence forces in a period of emergency.

In view of these considerations we feel that the department should train at least 50 men annually in Tele-communication, navigation, aeronautical engineering etc. This number should be over and above the normal departmental requirements.

RAIL TRANSPORT

Present Position

46. The Railways are State-owned and State-managed and the department is one of the largest employers of technical manpower. The activities of the department cover construction and maintenance of railroad-tracks; construction, maintenance and repair of all kinds of rolling stock ; overhaul of locomotives ; maintenance and gradual improvement of signalling system and installation of other safety devices, training of personnel, research and standardization of railway equipment and maintenance of workshops etc. Arrangements for all necessary services in respect of passenger traffic, goods traffic, and for the general welfare of all the employees of the department are also initiated and carried out. At present there are 5 chemical and metallurgical laboratories under the Railways, one each at Jamalpur, Bombay, Ajmer, Madras and one maintained by the B. N. Railway. About 38,000 miles of rail-road-track is maintained. A separate division under the Ministry of Communications is incharge of inspection of the working of railways.

47. The department has organized a Central Standards Office for preparation and maintenance of specifications for railway equipment. The various state Railways recommend the items to be dealt with through their Standardization Committees and also finally approve of the specifications and drawings. A research branch in this office has also been organized for the purpose of investigations on various items of interest to the railways and to prepare new designs and revised specifications based on the research results.

Staff Employed

48. Technical staff is recruited for the construction and maintenance of Railway services. For the research organization, however, experienced staff having special qualifications and aptitude for research is taken from the Railways. For the inspectorate division also the staff is taken from Railways but after confirmation is not allowed to revert to the railways. The numbers employed in various categories are :—

	Officers	N. G. O.	Total
Civil Engineers (Railway Engineering)	662	473	1,135
Mechanical Engineering	282	492	774
Electrical Engineering	82	153	235
Refrigeration Engineers	6	46	52
Medical Personnel	70	273	343
Mining Engineers	2	3	5
Marine Engineers	2	12	14
Metallurgists } Chemists }	7	3	10
Biological Science	..	2	2
Architects	3	..	3
Research Staff			
Civil Engineers	5	..	5
Mechanical Engineers	9	..	9
Electrical Engineers	1	..	1
Metallurgists	1	..	1
Draftsmen	..	13	13
Chargemen and Inspectors	..	6	6
Inspection Staff			
Railway Engineers	6	..	6
	1,138	1,476	2,614

Development Programme

49. The development plans envisage construction of locomotives and other rolling stock, improvement of existing and provision for additional marshalling yard facilities, large scale construction of staff quarters, remodelling of workshops, provision for increased amenities for passengers, especially 3rd class passengers, quicker goods traffic, installation of tele-communication control system, and gradual electrification of railways. Additional construction of new lines covering 1,117 miles is also contemplated. The construction of India-Assam rail link of 156 miles has been taken in hand.

50. Proposals have also been made for the re-organization of the Central Research Section and other railway laboratories to undertake work on problems of fundamental and applied sciences as affecting railways. The scheme envisage 8 divisions under Directors, carrying out research work on civil and mechanical engineering, chemical and metallurgical problems and general stores, fuel, water, oils and paints etc. It was also intended that some of the problems be referred to National Laboratories. No information has been given on staff requirements for the organization, as for the present its execution has been postponed. It is, however, understood that no abnormal recruitment is expected to take place and the requirements are likely to be met from the existing staff of railways.

Staff Requirements

51. Staff requirements for all the Railways may be considered under two distinct heads :—

(*a*) Replacement on account of wastage and retirement etc. and

(*b*) Requirements for new development projects and research development.

Based on average annual intake the requirements of the next five years have been stated as :—

	Officers	Non-Gazetted Officers	Total
Medical Personnel	47	55	102
Chemists	8	5	13
Civil Engineers (Stores Depts. Signals)	272	..	272
(Bridge Inspectors, P.W.Is. Signal & Block Inspectors, Assistant Inspectors).	..	389	389
Estimators, Draftsmen	..	32	32
Mechanical Engineers (Chargemen, Asstt. Foremen, Draftsmen, Fitters, Boiler makers, Production Supdts.)	154	..	154
(Train Examiners, Apprentice Mechanics, drivers, shunters and firemen).	..	79	79
Electrical Engineers	72	..	72
(Foremen, Chargemen, Asstt. foremen, Draftsmen, apprentice mechanics).	..	20	20
Mining Engineers	2	..	2
Electrical Engineer, Telecommunication	..	27	27
Marine Engineers	..	7	7
Inspection Department Railway Engineers (Civil)	10	..	10
	565	614	1,179

52. Staff requirements for new projects have not been worked out so far. Only requirements for India-Assam Rail link have been worked out and the project has been taken in hand.

These requirements are :—

Executive Engineers	(Civil Engineer)	12 Gazetted
Sub-division Officers	(Civil Engineer)	36 Gazetted.
Subordinate staff (I.O.W., A.I.O.W., P.W.I., A.P.W.I.)	(Civil Engineer)	240 Non-Gazetted
Draftsman, estimators, tracers		120 Non-Gazetted
		408

The department feels that for other projects new staff will not be required as each project will be taken up as soon as the preceding one is nearing completion and the staff so released could be utilized on the new project.

53. For the increased research activities, however, sanction of 7 posts has been asked for and it is hoped that the appointments will be made in the current year. Staff required will be 6 mechanical engineers and one fuel technologist.

Total staff requirements for the next five years, therefore, are :—

1594

Pattern of Employment

54. The railways require engineers (civil, mechnical, electrical) and their corresponding non-gazetted staff in large numbers. The civil and electrical engineers (gazetted) are, however, recruited after a competitive test conducted by the Federal Public Service Commission. The minimum qualification for this type of personnel is a degree from a recognized institution or equivalent qualifications. They are subsequently provided training for the specialized needs of the railways. The mechanical engineers, however, are specially trained by the department at their training centre at Jamalpur. Subordinate staff of various categories is trained by the department on various railways and workshops. Medical personnel find employment in the railways for the medical treatment of the railway staff. Small numbers of metallurgists and chemists are also employed in the laboratories maintained by the Indian State Railways for testing of stores and other routine type of research work. It will be noted from the paras 53 and 54 that the total staff requirement of engineers is 404 officers (excluding mechanical engineers) and 835 non-gazetted officers.

55. It is a usual practice in other departments employing engineers that a certain number of graduates are also employed in non-gazetted posts. Here also we may assume that a similar percentage, *viz.*, 25% of non-gazetted staff, will consist of engineers having degrees. The total number of engineering personnel holding degrees and diplomas, required therefore amount to :

	Degree	Diploma
Civil Engineers	525	586
Electrical Engineers	84	35
Mining Engineers	2	..
Marine Engineers	1	6
Mechanical Engineers*	180	59
Medical personnel	102	..
Fuel Technologist	1	..
Chemists	13 (post-graduates)	

*So far as mechanical engineers are concerned, their basic qulifications prior to the training may be taken as equivalent to Intermediate Standard. Since the period of training extends over 4 years, these personnel may be considered as equivalent to graduates in engineering. The department will no doubt make such arrangements for training as is codsidered necessary.

Training Facilities

56. The training facilities available on the Railways may be considered adequate for their departmental needs. For instance the training school in Jamalpur can train 20 to 30 men a year. It is however, not possible to increase the number of trainees at this school on account of lack of accommodation and training facilities in the workshop. Other workshops under the control of the railways have very good training facilities for general mechanical engineering, structural engineering, and electrical engineering. The railway laboratories have good facilities for training in ferrous and non-ferrous castings, heat treatment of alloys, etc., but the research facilities are not adequate. The construction of large locomotives under the auspices of the railways is likely to be started sometime in 1950.

57. Certain facilities available in the railways are not available elsewhere in the country. In view of the necessity of training a larger number of engineers for the various development projects, it is felt that the railway workshops should be asked to train 150 engineers over and above the requirements of the railways themselves. The railways' laboratories offer good training facilities for practical training in metallurgical problems and it is suggested that 30 students may be acco mmodated at various laboratories.

MERCANTILE MARINE

58. The Ministry of Commerce administers:—

(*a*) *The Mercantile Marine Department.*—This Department supervises and surveys all shipping, both foreign going and home trade, conducts preliminary enquiries into shipping casualties and boiler explosions and renders necessary advice and co-operation during formal investigations, surveys small launches and crafts belonging to Provincial Governments on their behalf, carries out surveys of river and harbour craft, conducts examinations of personnel for certificate of competency, carries out duties of

detention of unsafe ships, supervises construction and repairing of ships on behalf of other Ministries, quasi-Government, and private bodies and is responsible for general administration and framing of rules and rules applicable to merchant shipping.

(*b*) *Central Light House Department.*—This department arranges for the lighting of Indian coast in accordance with recognised international standards.

(*c*) *I.M.M.T.S. "Dufferin" and Nautical Engineering College.*—These institutions train engineering and nautical personnel required by the mercantile marine. The facilities available have been discussed in detail in the relevant section of this report (*viz.* para. 72).

Present Position of the Mercantile Marine

59. Before the war India had about 30 ships of total 1·5 lakh gross tons. For service in a long coast this tonnage was very inadequate. In 1946 Indian Shipping Companies numbered 11 and had 49 ships of gross 1·27 lakh tons. Since then 14 ships totalling about 84,000 tons have been purchased and put under service. The ship building and purchasing activities of M/s Scindia have increased the Indian shipping by another lakh tons. It has been stated that the total Indian tonnage registered in India at present is about 3·5 lakh tons.

60. The Commerce Ministry of Government of India appointed a Sub-Committee of the Reconstruction Policy Committee to make recommendations on the shipping policy of the Government. In making these recommendations the Sub-Committee considered the history of the development of Indian Shipping and its present position particularly with reference to the effect of the last war on Indian shipping, and have recommended to the Government to adopt " a dynamic national shipping policy ". It has also been suggested that Indian shipping should be defined as shipping which is owned, controlled and managed by Indian nationals. The Government has approved the recommendations and, apart from various proposals which are under consideration for the rapid expansion of the Indian Mercantile Marine and its activities, a scheme has been proposed by the Ministry of Commerce to ensure a rapid increase in the Indian-owned tonnage and its increased participation in overseas trade. The main points of the policy are :—

The Government should take an initiative in establishing two or three Shipping Corporations, the Government contributing 51% of the capital and the balance to be contributed by Shipping Company or public ; each Corporation to operate 100,000 tons of shipping and that no private company is to be associated with more than one Corporation.

61. The Government's participation in such a manner will facilitate acquiring tonnage from abroad as negotiations have generally to be conducted on Government to Government level, secure admission of Indian shipping companies to International Shipping Conferences, ensure flow of private capital in this industry and prevent unhealthy competition and eliminate establishment of monopolies.

Staff Employed

62. We have not been able to obtain any information about the number of technical personnel at present employed in the Mercantile Marine. Usually, technical personnel of the following categories is employed :

Engineering Personnel, and

Executive Personnel or Nautical Personnel.

The staff employed in other organisations mentioned in para. 62 above is as follows :

Engineer and Ship Surveyors	16 officers.
Ship Surveyors	2 officers.
Nautical Surveyors	11 officers.
Tele-communication Engineers (Wireless Inspectors)	2 officers.
Marine and Nautical Officers	14 officers.
Electrical Engineers	2 officers 1 non-gazetted officer.
	48

Development Programme

63. The Committee analysed the volume of internal coastal trade and India's trade with her neighbours and considered the inadequate and expensive rail transport, necessity of moving foodstuffs from abroad in time to prevent famines and concluded that rapid growth of shipping industry is a vital necessity to India. For Indian shipping to handle 10 million tons of cargo and 3 million passengers annually it was estimated that India must possess at least two million tons of shipping by the end of next 5—7 years. For an equitable distribution of trade mutual arrangements can be made between various Indian shipping companies and to facilitate this and other allied work the establishment of a Shipping Board has been recommended so that such matters as deferred rates, rate cutting and other monopolistic evils may be eliminated.

64. To achieve this target of two million tons of shipping in the next five to seven years the Committee has suggested that the Government should purchase ships from U.K. and U.S.A. and at the same time encourage ship-building industry in the country by giving suitable concerns the patronage and facilities necessary for economic operation. Scindias have started the construction of ships of 8,000 tons at Vizagapatam and the first Indian-built ship was recently launched. Provision of 6 berths exists in the Scindia's shipyard but additional shipyards and more building beths are considered necessary. The staff requirements for ship-building industry are considered elsewhere in the report.

65. A committee constituted by the Government of India to advise them on the manner of expanding the facilities for the training of Merchant Navy Officers has recommended the establishment of a Nautical and Engineering College to be set up at Bombay for coaching candidates preparing for their professional examinations. Further, the Ministry of Commerce should set up a central organization to supervise and co-ordinate the activities of training establishments whether at sea or at shore. This recommendation is under consideration of the Government.

Staff Rquirements

66. As a result of the decision to expand the shipping tonnage, it will be obvious that the present inadequate training facilities will have to be improved considerably. It has been estimated that to man 2 million tons of shipping at least about 1,500 certified deck and 1,000 certified engineering officers will be required. This number is in addition to what will be produced by the use of the existing facilities.

A schedule of requirements has been drawn up for the proposed Nautical College and the staff required is estimated as follows :

Captain Superintendent	1
Head of Engineering Division	1
Lecturer Navigation and Seamanship	1
Lecturer, Mathematics and Science	1
Lecturer, in Engineering	1
Signalling Instructor	1
Instructor in Mechanical Drawing	1
Total	7

As estimated earlier, two types of technical personnel are generally employed in the Mercantile Marine. Both types receive special training and have to pass examinations of certain standard, *viz.*, competency examinations. So far as the engineering personnel are concerned we may consider them as roughly equivalent to degree holders in mechanical and/or electrical engineering in regard to technical proficiency. Under abnormal conditions qualified mechanical/electrical engineers can take charge of the marine installations after a period of sea service.

The Mercantile Marine Department of the Ministry of Commerce would, however, require the services of about 15 engineer and ship surveyors and 15 nautical surveyors during the next 5 years.

67. Since the requirements of the Mercantile Marine Mentioned above are exclusive of the number of persons trained by the " *Dufferin* " during the next 5 years on the present normal rate, we assess the total requirements as follows :—

Engineering personnel	1,147
Nautical personnel	1,647
	2,794

Training Facilities.

68. For the training of executive and engineering staff required by the Indian mercantile Marine facilities is at present available only on the training ship "Dufferin". 50 candidates are recruited every year, 25 for executive posts and 25 for engineering. The course of training for engineering cadets in the "Dufferin" is composed of pre-sea training over a period of 3 years and practical training in approved workshops for another period of 3 years. After completion of this the cadets go to sea for practical training for 2½ years. They can then sit for their professional examination. Similarly, nautical cadets after completing their course of training at the "Dufferin" proceed as apprentices on foreign going ships. They can then take their examination of competency.

69. The Committee appointed by the Government to advise them on the Merchant Navy Officers Training have also considered the possibility of increasing the number of cadets in the "Dufferin". It has been stated that on account of the length of the training period and the specialised training they receive it is not possible to increase the number of apprentices by more than 10. They have therefore made other proposals for meeting the requirements of the mercantile marine.

70. The desirability of introducing special curriculum in the existing technical institutions or Universities was also considered but members were of the opinion that although such arrangements could be made with Government aid it will not be possible to impart the specialised kind of training necessary for deck and engineering officers.

71. In their 4th interim report the Committee has recommended to the Government that for engineering students all entrants should be appointed directly to approved workshops as apprentices for a period of 3 years. The age of entrants should be between 16 to 19 and that they should pass the higher secondary or inter-science examination. During the period of workshop training they should attend evening classes either at the Nautical and Engineering college or at some other suitable engineering college. After completing the apprenticeship period the boys should be admitted to a residential pre-sea establishment for advanced instruction in marine engineering for one year. They should then go to sea for practical training on ships. The Committee has assessed that in the next 3 years it will be possible to accommodate 240 workshop apprentices, 120 at Bombay and 120 at Calcutta (80 apprentices being admitted each year).

72. In regard to nautical cadets the Committee has recommended that in future engineering cadets should not be accepted in the "Dufferin" and that 55 nautical cadets should be accepted for a 2 year course beginning in January 1949 and then the number be increased to 80 from 1950 onwards. Cadets who joined for engineering course in 1948 should complete their training in the "Dufferin" for 2 years and then should be apprenticed to workshops. In case these recommendations are accepted it will be necessary to increase the staff of the "Dufferin". It is also understood that the training facilities can be expanded, if necessary.

73. The Merchant Navy Training Committee while stating that in normal circumstances pre-sea training is necessary, have urged that to meet the existing shortage of officers, a large number of carefully selected young boys should be apprenticed directly to ships for four years' practical training. Negotiations in this connection are now reported to be progressing with the shipping companies. It is possible that 100 boys may be thus placed within 6 months from now.

Port Trust Administrations.

74. The Port Trust authorities are under the administrative control of the Ministry of Transport except Vizagapatam which is under the Railway Ministry. Completed questionnaire have been returned by the Bombay Port Trust, the Madras Port Trust, the Calcutta Port Trust and the Cochin Port Trust only.

Scope and Functions.

75. The Port Trust authorities make necessary arrangements for the construction and maintenance of docks, warehouses, port dredgers and other floating craft, ship-repair workshop, shore plants and other mechanical appliances such as electric and steam cranes, and for maintaining liasion with the railways for quick transport of goods from the wharf to destination. The Bombay Port Trust also carries out

applied research on a tidal model of the Bombay Harbour. Some tidal models are also being prepared for the Calcutta, Madras and Cochin Ports at the CWINC Research Station at Poona for the following purposes :—

Calcutta.—Ship Canal Scheme.

Madras.—Reduction of 'range' in the Harbour

Cochin.—Reduction in the cost of maintenance of dredging.

Technical Staff Employed.

76. The technical staff employed consist mainly of engineers. The number is as follows :—

	Officers.	N. G. O.
Civil Engineers	56	25
Electrical Engineers	45	2
Mechanical Engineers	158	16
Marine Engineers	92	2
Medical Personnel	1	..
Production Engineer	1	..
	353	45

The engineering personnel employed possess an engineering degree or its equivalent.

Development Plans.

77. The development schemes under the consideration of the Port Trusts, generally speaking, consist of reconstruction of sheds and ware-houses, modernisation of docks, provision of additional wharfs and berths, extension of railway sidings, additional housing for Port Trust Labour etc.

Staff Requirements.

78. Total requirements for replacement on account of retirement etc. has been estimated by the organisations as 6 civil engineers, 7 mechanical engineers and 1 electrical engineer. The Staff required to undertake new construction has been estimated as 11 Civil Engineers (Officers). Most of the additional staff will be appointed in a temporary capacity as the departments feel that with the existing staff and their replacements they will be able to maintain the installation in good working order.

Total staff requirements are :—

Civil Engineers	27
Mechanical Engineers	10
Electrical Engineers	1
	38

Training Facilities.

79. The Port Organisations have facilities for training in ordinary routine type of electrical and mechanical engineering. The Cochin Port is already providing training to students from Engineering Colleges. They have, however, pointed out that adequate training facilities in naval architecture and ship building are not available in the country and that for these subjects training will have to be organized in U. K. or U.S.A.

Roads Organization.

80. On the recommendations of the Indian Roads Congress, an all-India body of eminent road engineers, the Central 'Roads Organisation' was set up a few years ago to advise the Central, Provincial and State Governments on various technical matters relating to road design, standards and construction. A Central Road Research Institute is being in the process of established under the joint sponsorship of the C. S. I. R. and the Central Roads Organization. An Economic Research Branch of the Central Roads Organisation was opened in December 1945 and has done some good work on road economics and allied studies in this short period. The Roads Organisation works as a Consulting Engineer's Office mostly in an advisory capacity. Private firms like the Concrete Association of India have been collaborating in the experimental work. The Indian Roads Congress and the Roads Organization are co-operating in every way to evolve the most suitable standards and designs for various types of roads and bridges and for advancement of all aspects of roads-technique.

Staff Employed.

81. The present staff employed is 27 officers (26 Engineers and 1 Statistician) and 59 Non-Gazetted Officers (52 Engineer Subordinates and 7 Statisticians). The staff originally proposed consisted of 60 officers and 160 Non-Gazetted Officers but the complete proposal has not been accepted by the Government.

Development Programme.

82. The road development programme as embodied in various Central and Provincial Plans can be considered under the following heads :—

(*a*) *Central.*—New Developments and improvement of National Highways. New Construction of 687 miles of highways and improvement of 5 421 miles of existing roads has been planned. The construction will be financed by the Central Government but execution will rest mainly with the Provincial P. W. D.

(*b*) Construction of provincial, district board and village roads. Construction of 40,500 miles of new roads and improvement of 33,393 miles of existing roads and construction of over 500 important bridges (more than 40 per cent. of which will exceed 2000 feet in length) are contemplated. The expenditure will be met by the Provincial Governments and the execution will rest with the provincial Public Works Departments.

(Figures relate to undivided India.)

Staff Requirements.

83. It has been estimated that at present about 1,000 engineers are employed on works connected with roads. Most of these have to perform additional civil engineering duties. There has been an under recruitment during the war-years and it is likely that in the next 5 years there will be an abnormal demand for road engineers from the provinces and states. However, it is very doubtful if more than 2,000 officers will be engaged on road work in foreseeable future. Secondly, on account of violent fluctuations in development programmes any calculation of staff requirements cannot be considered as accurate. Assuming an annual intake of 4 per cent. and allowing for the lee-way to be covered, it has been estimated that 80 engineers and 400 subordinates may be needed per year. As is usual in other department employing engineers, about 25 per cent. of the subordinate officers may be assumed to have degree qualification or its equivalent. The total staff reuquirements in the next five years may thus be classified as :—

	Degree.	Diploma.
Civil Engineers (Highway Engineering)	900	1,500

Pattern of Employment and Training Facilities.

84. The department maintains a road test-track at Calcutta and has obtained very valuable data. Field experiments are also being conducted in various parts of India and the Provincial/State Government are kept posted with the research results.

85. The staff employed in the Central Roads Organisation itself requires specialized post-graduate training. The special training pertains to knowledge of soils, behaviour of building materials under different climatic conditions, design and construction of roads and bridges and other allied problems. The conditions are further complicated by the variety of road transport employed in the country. At present there is only one institute which imparts separate training in high-way engineering, but it offers no facilities for post graduate training.

86. In view of the absence of post graduate training facilities in high-way engineering it is suggested that a percentage of the employees of Provincial/State Governments employed on road construction be deputed for short periods of training under experts employed in the Roads Organization. If 10 per cent. of the required roads engineers (*i.e.*, 90) possessing degree or equivalent qualifications in civil engineering are thus trained, we feel, that the country's requirements for this highly specialized category of staff would be adequately met. Specialised study in foreign countries may, however, be arranged for a few selected officers at a later date, and it has been suggested that if four such selected officers were sent annually for this specialised training the output will be enough for our requirements in the next quinquennium.

**Broadcasting.*

87. Broadcasting in India was started by a private Company in 1927 which went into liquidation in 1930. The Government of India took over the concern in that year and the service was placed on a sound footing. There were only 3 broadcasting stations at Bombay, Calcutta and Delhi before 1936. Since that year there has been gradual and steady development of broadcasting in India. Three medium wave stations were set up at Madras, Lucknow and Tiruchirapali and the transmitting facilities at Delhi, Bombay, Madras and Calcutta were supplemented by the installation of one 10 k.w. s.w. transmitter. Also one 5 k.w. s.w. transmitter was installed for Central News Service at Delhi.

88. During the war, broadcasting development received a fillip particularly in the direction of Home News and External Broadcasts. To provide adequate coverage for News Bulletins, one 10 k.w. s.w. transmitter was locally designed and put up in Delhi. Between 1943 and 1945, two 100 k.w., two 20 k.w., and two 7½ k.w. short-wave transmitters were installed and brought into opearation at Delhi, to cover the Far East, the Middle East, and the South East Asia.

Staff Employed.

89. There are at present about 43 gazetted officers and 266 technical officers in the Engineering Section of AIR. Generally two types of Technical staff are employed, *viz.*, Engineers (Electrical/Tele. Communication) and Physicists with Wireless as a special subject. They are at present in the proportion of one to two.

Development Programme.

90. Early in 1947 an Eight Year Plan for the development of broadcasting was drawn up. This plan envisages the establishment of ten 50 k.w. transmitters, two each at Bombay, Madras, Calcutta, Delhi and Allahabad; and new broadcasting stations of 10 or 20 k.w. power at Cuttack, Shillong (Gauhati), Nagpur, Ahmedabad, Bezwada, Dharwar, Calicut and one at the capital of the East Punjab. However, in view of the time that would be involved in the erection of these higher power broadcasting stations and in making a large portion of the country radio minded before the completion of the regular scheme, a pilot scheme has been introduced. Under this scheme, broadcasting stations have been opened at Cuttack, Shillong (Gauhati), Nagpur and the remaining stations are to be completed as soon as possible. Simultaneously work is in progress on the regular scheme. There are at present 13 stations, 13 receiving centres and 25 transmitters.

***The questionnaire issued by the Committee has been completed and returned only by the A. I. R. and the Overseas Communication Service. Some information contained herein has been ascertained informally from the Ministry of Information and Broadcasting.**

Saff Requirements.

91. The number of technical officers required for the execution of the Five Year Development Plan is approximately 75, out of which 16 will be gazetted officers and 59 will be non-gazetted technical officers. The annual intake of engineers required for the operation and maintenance of the Broadcasting stations will be about 80 in the first year and 50 per year for the next 4 years. During the period from 6th to the 10th year, about 300 engineers are likely to be needed.

92. For the proposed expansion of the Overseas Communication Services it has been stated that 6 officers (Engineers) and 70 Non-gazetted officers will be needed.

93. For the information Film of India applications have been invited for the following posts :—

Documentary and Information Films	Dy. Controller	2
	Assistant Controller	2
	Director	6
	Camera Men	16
	Laboratory Supervisor	1
	Sound Technicians & Recordists	5
		32

(This list excludes such staff as need have only arts qualifications).

Pattern of Employment.

94. As stated before, generally two types of technical personnel are employed viz. Engineers (telecommunication or electrical engineers trained in tele-communication) and physicists with wireless as special subject The engineering personnel employed, generally speaking, possess degree or equivalent qualifications. It may further be assumed that physicists will form about 1/3rd the total requirements (unless otherwise classified). For the documentary films, however, specialist type of staff will be needed. We have designated this staff as cinematograph experts as this personnel will be drawn from personnel experienced in the cinema film production industry.

The requirements may, therefore, be classified as :—

Engineers* (tele-communication)	337 (Degree holders). 72 (Diploma holders).
Physicists	50 (with wireless as special subject in Post Graduate course).
Cinematograph experts	47
	506

(This includes the requirements for Overseas Communication Services).

Training Facilities.

95. The engineering section of AIR has good training facilities in the installation and maintenance of radio equipment and tele-communication engineering. The Department has started a Training School for giving advanced training to apprentice engineers in the design, operation and maintenance of studios, transmitters, recording equipment, aerials, receiving equipment, etc. The school takes approx. 30 trainees for a six month ' training.

The department is of the opinion that in order to keep pace with the latest developments in various branches of broadcasting, it will be necessary to depute two senior and experienced members of the technical staff for practical training abroad. They may be sent for six months every year. In addition, six students who have had a good academic career should also be sent annually on State scholarships.

96. The department is of the opinion that in order to keep pace with the latest developments in various branches of broadcasting it will be necessary to depute 2 senior and experienced members of the technical staff for practical training abroad. They may be sent for 6 months every year. In addition six students who have had a good academic career should also be sent annually on state scholarships. In 5 years, therefore, 40 students should be sent for foreign training.

Puvlic Works Departments including Irrigation.

97. The Public Works Departments of the Central Government Provinces and Indian States are responsible for a wide range public utility activities which chiefly relate to civil engineering projects like construction and maintenance of public and Government buildings, irrigation projects, dams, tanks and canals, national highways and other roads, bridges, protected water supply, municipal and sanitary engineering and town planning. A substantial part of the activities of these departments is confined to maintenance of works.

It may be mentioned here that for some of the new projects the preliminary investigational and planning work is entrusted to such organizations as the Central Waterpower, Irrigation and Navigation commission (CWINC), the Central Electricity Commission, the Damodar Valley Administration etc. The departments concerned also collaborate with these organizations in drawing up the plans for any particular project. The execution of the plans is the responsibility of the Provincial/State department, and the central organization only retains supervisory and advisory roles. The Commission has been charged with the general responsibility of initiating, coordinating and furthering, in consultation with the Provincial and State Government concerned, schemes except the Damodar Valley Scheme for the control, conservation and utilisation of water resources throughout the country, for purposes of waterpower generation, irrigation, navigation and flood control and, if so required, the construction of any such schemes on behalf of the Government of India.

98. The activities of the CWINC are coordinated through its Central Office at Delhi. The Chairman of the Commission, its Members and Directors are experienced engineers who carry out the planning work. The department maintains a research station at Poona for investigating problems bearing on river characteristics, river hydraulics, design of canals, navigation, soil mechanics and investigations on cement, concrete and other building materials. The main object of these research establishments is to obtain fundamental data for new concepts and methods and to obtain information about their practical application, developing quick laboratory tests, organising field tests and to render technical advice on practical engineering problems. This research station provides research facilities in general hydraulic engineering.

99. It may be mentioned here that the Government of Madras has organized an Irrigation Research Station at Poondi for obtaining economic and efficient profiles for spillways and dams ; determination of coefficient of discharge from dams and sluices ; dissipation of energy and prevention of scours down-stream and spillways dams, falls, anicuts and barrages ; remodelling sluices, culverts and under-tunnels , economic design of tanks and weirs ; exclusion of silt from distributaries ; river training work ; and design of coffer dams etc. The soil mechanics laboratory at Madras is carrying out investigations on systematic analysis of soil in river beds, dams sites and for other irrigational projects. The building of the research station in Madras has just been completed and preliminary investigations on testing various types of materials are being conducted.

100. *Staff Employed.* We give below a list of staff employed by various departments :—

Central Public Works Department.

	Officers.	N. G. O.
C. P. W. D.		
Engineers (all categories)	181	1,503
C. W. I. N. C.		
Engineers (Civil and Mech.)	49	46
Electrical Engineer	3	1
Physical Chemists	1	4
Mathematicians and Statisticians	4	4
Meteorologist	1	3
Geologists	1	..
Soil Conservation Expert	1	..

Damodar Valley Administration.

101 Staff for the initial investigations was loaned by various organizations who have been carrying out collaborative work. No technical staff was employed exclusively for this project so far.

Public Works Department (Provincial).

	Officers.	N. G. O.
U. P.		
Civil Engineers	200	474
States. (Sirmur, Gwalior, Nabha, Jaipur, Jammu and Kashmir).		
Civil Engineers	47	81
Electrical Engineers	12	34
East Punjab.		
Physicists	1	2
Chemists	3	7
Mathematicians	2	8
Agricultural Science	11	..
Engineers Civil	175	Not-stated.
Engineers Mechanical	23	20
Engineers Electrical	2	..
Patiala Government.		
Engineers Civil	17	..
Engineers Electrical/Mechanical	5	..
Jodhpur.		
Civil Engineers	16	50
Bihar.		
Civil Engineers	121	215
Electrical Engineers	7	30
Architects and Town Planners	1	..
Orissa.		
Civil Engineers	53	175
Mechanical Engineers	1	2
Electrical Engineers	6	11
Architects and Town Planners	2	2
Assam.		
Civil Engineers	53	225
Mechanical Engineers	2	3
C. P. & Berar.		
Civil Engineers	110	574
Mechanical Engineers	3	26
Electrical Engineers	..	5
Architects and Town Planners	3	..
Bombay.		
Civil Engineers	197	..
Electrical Engineers	29	..
Architects and Town Planners	1	..
Soil Physicists	2	..
Public Health	17	..

	Officers	N. G. O.
Madras		
Civil Engineers	19	32
Road Engineers (Civil)	151	616
Mechanical Engineers	6	32
Irrigation Engineers (Civil Engineers)	326	1,427
Municipal and Sanitary Engineers (Civil)	7	55
Mechanical Engineers	13	14
Architects and Town Planners	2	7
Soil Mechanics	2	..
Physicists and Chemists	2	..
Mysore Government		
Civil Engineers (Irrigation, Buildings, Roads, etc.)	139	909
Cochin		
Civil Engineers	19	44
Travancore		
Civil Engineers	40	118
Architects and Town Planners	3	..

The staff employed may be classified as :—

Civil Engineers	1,929	6,544
Mechanical Engineers	48	97
Electrical Engineers	64	81
Architects and Town Planners	12	9
Soil Conservation Experts	5	..
Chemists	6	11
Meteorologists	1	3
Geologists	1	..
Mathematicians and Statistician	6	12
Public Health	17	..
Physicists	1	2
Agricultural Science	11	..
	2,101	6,759

Development Programme

102. The development programmes of the Central Public Works Department are dependent on the development programmes of other departments, the C. P. W. D. being only an executive agency for civil engineering jobs. As mentioned earlier, special sections of the department are attached to other organizations in order to facilitate construction work *e.g.*, the works department attached to the Directorate General, Civil Aviation.

103. The CWING has carried out reconnaissance survey for a large number of schemes and plans that are being drawn up for the multi-purpose development of river basins such as Mahanadi basin, Kosi basin and Narbada, Tapti and Sabar Mati basins. Irrigation schemes for a number of Indian States and provinces have also been planned. These development schemes have been drawn up with the particular object of providing flood control, providing perennial supply of water for irrigation, generation of hydro-electric power and of possibly providing river navigation so as to ease the rail transport position. Preliminary work on the Damodar, Mahanadi and Kosi Scheme is in an advanced stage and the construction work on them have been started already. The development of Damodar river has been entrusted to the newly constituted Damodar Valley Corporation Administration and it is expected that they will take up the construction work on the project during the current year. The entire development programme will be spread over a number of years. Each project may take 5 to 7 years to be completed. The construction programme has been staggered with a view to overcome the shortage of trained men and acute shortage of building materials such as cement, iron and steel. A Central Designs Organization

is being set up by this Department. After this organization starts functioning it will offer specialized facilities in design work, particularly for high dam construction and big irrigation projects. On the research side also the department proposes to increase its activities relating to river hydraulics, navigation, tunnels, soil mechanics, and such other problems as design, construction, operation and testing of scale models of hydraulic structures *e.g.*, masonry and earth dams, embankments, spillways, out-let works, siphons, aquaducts, regulators, etc. The research station also caters to the needs of provinces and states so far as India's water problems are concerned. The co-ordination of these activities is carried out by the Central Board of Irrigation so as to avoid overlapping and duplication of work at other institutes.

104. Development plans for the P. W. Ds. of some of the Provincial Governments have not been given in detail, but in general they relate to construction, maintenance and improvement of public buildings, roads, bridges, culverts and other similar projects.

105 The Public Works Departments of some of the States in the Northern Zone carry out development of mineral resources and generation of hydro-electric power in addition to the above civil engineering duties.

East Punjab

106. The Irrigation and Public Works Department of the East Punjab Government have not given any information but it is generally known that the Government has completed the preliminary work for the construction of Bhakra project. The planning of a new capital for East Punjab has also been undertaken.

Orissa

107. The development programme of the Orissa P. W. D. consists of a comprehensive road development project involving an expenditure of Rs. 7 crores and construction of road bridges over the Mahanadi and Kathjuri rivers. The development of projects on the Mahanadi river would enable more water to be supplied for irrigation purposes. Minor irrigation projects are being planned and executed involving a cost of Rs. 60 lakhs. As a temporary measure the Government is considering a proposal for providing flood control by construction of double embankment with high level escapes along the banks of the rivers where they are most threatened by danger of floods. The scheme is estimated to cost about Rs. one crore. Construction of small aerodromes is also anticipated. Recently town-planning for new capital of Orissa at Bhuvaneswar has been taken in hand.

Bihar

108. The development scheme envisages construction of bunds, tanks and repair of tunnels and well for improving the water supply for irrigation, training of Kosi river, and a road development programm covering a total of about 36,000 miles. A thermal electric grid system is being planned to supply powe to central parts of Bihar. This will be linked up to the hydro-electric stations on the Damodar river.

Assam

109. The development programme covers a long range scheme for road development covering a total of 1,323 miles, construction of government buildings for the Central Press and Secretariat Buildings and reconstruction of buildings destroyed by enemy action during the last year. The rural development covers arrangement for supplying water in villages, settlement of ex-servicemen, colonization of waste land, village up-life, etc.

C. P. & Berar

110. The development programme consists of two main schemes—one for development of roads and the other for improvement of irrigation.

Bombay Presidency

111. The Bombay Presidency also envisages development of roads, buildings, irrigation, electric grid and public health.

Madras Presidency

112. Plans have been drawn up for provision of protected water supply and drainage to all municipalities having a population of 10,000 and above. This project has been divided into 4 five-year projects. About 200 major and minor building schemes for various Government departments are under consideration for completion in the first five year plan. For the irrigation and inland water-ways also 300 small reconstruction schemes have been planned. In addition very large irrigation projects like the Tungabhadra Project*, Lower Bhawani Project, Ramapada-Sagar Project and Kistna project are under consideration for execution during the next 5 to 10 years. The completion of these projects will generate enormous amounts of hydro-electric power, irrigate considerable areas and will entail construction of roads, highways and bridges.

Mysore

113. The development projects of Mysore Government envisage special irrigation schemes for bringing under irrigation 210,000 acres, rehabilitation of old works, and construction programmes for various departments of the Government and other public institutions.

Travancore

114. Special irrigation projects costing Rs. 1 crore and minor irrigation projects costing abous Rs. 20 lakhs per year have been planned and construction of concrete highways over a length of 200 mile is under consideration. Construction of about 200—250 bridges the most important being one connecting Cochin with Travancore, has been planned. Construction of public buildings costing Rs. one crore is also contemplated.

Staff Requirements

115. The staff of a Public Works Department consists of chief engineers, superintending engineers, divisional engineers, assistant engineers (all gazetted officers) and supervisors, overseers, draftsmen and tracers (non-gazetted officers). The Public Works Departments employ civil engineers in large numbers and also a few electrical and mechanical engineers.

The requirements of the staff may be considered under two heads :—

(*a*) Regular intake, (*b*) staff required for special projects likely to be undertaken during the next five year period.

Central P. W. D.

116. No large scale recruitment is likely to take place in this department. Almost 50 per cent of the staff employed is on a temporary basis and the recruitment will be confined to replacements on account of retirement, etc. Five year's requirements have been estimated as :—

	Officers	*Non-Gaz Officers*
Civil Engineers	18	150

*Work on Tungabhadra project has already started.

CWINC.

At present a number of posts are vacant and are likely to be filled in the near future. These comprise civil engineers for construction work and engineers and scientific staff for research stations (including soil experts, chemists, forest officers etc.) For the new projects which have been planned, additional staff would be required. The total requirements for the entire organisation during the next 5 years are as shown below.

	Officers.	N. G. O.
Civil Engineers	638	1,580
Electrical Engineers	48	120
Mechanical Engineers	33	96
Physical Chemists or Allied Research Officers	34	..
Malariologists	8	..
Soil Specialists	8	..
Meteorologists	6	..
Forest officers	8	..
Medical personnel	8	32
	783	1,828

D modar Valley Project.

117. The construction of the poroject will be spread over a number of years but for the first three ars tentative staff requirements have been worked out as follows :—

	Officers.	Non-Gaz. Officers.
Civil Engineers	49	
Mechanical Engineers	33	108
Electrical Engineers	16	
Soil engineers	6	..
Medical Graduates	12	..
Geologists	3	..
Architects	3	..
Zoologists	4	..
Agricultural Engineers	9	..
Chemists	10	..
Chemical Engineer	1	..
Statisticians	4	..
	150	108

118. *Provincial P. W. Ds.* :—

U. P.

Civil Engineers	50	100

Northern Indian States.

Civil Engineers	22	13

East Punjab.

The existing staff is surplus at present.

No intake is likely.

Patiala Government.

Civil Engineers	17	..
Engineess Electrical/Mechanical	8	12

Jodhpur Government.

Civil Engineers	1	...

Orissa.

Civil Engineers	15	91
Mechanical Engineers	1	..
Electrical Engineers	3	..
Architects and Town Planners	6	8

Bihar.

Civil Engineers	80	200
Electrical Engineers	33	200

Assam.

Civil Engineers	38	19

C. P. and Berar.

Civil Engineers	40	270
Mechanical Engineers	..	5

Bombay.

Civil Engineers	24	60

Madras.

Civil Engineers	464	1,773

Travancore.

Civil Engineers	50	220

Mysore.

No information has been given. It has, however, been estimated that the requirements on account of the replacement and retirements may be taken as 10 per cent. of the present staff approximately. The probable requirements are :—

Civil Engineers	153	1,000

Cochin Government.

Civil Engineers	19	75

119. The Public Works Departments invite contractors to execute the construction work. The contractor in his turn employs qualified engineers to supervise the construction. We have not been able to obtain any accurate information from leading contractors about the probable requirements of engineers. In view of the amount of construction work that will be taken up in the next 5 years we are of the opinion that the number of engineers would be approximately half of what the Government department would require *viz* :—

Civil Engineers	840	2,810
Electrical Enginneers	52	167
Mechanical Engineers	35	73

120. The following gives an over-all picture of the requirements of the engineering personnel for the Public Works Departments of the various Government and contractors during the next five year period.

Civil Engineers (buildings and steel structures, Irrigation projects, Hydraulic engineering and dams, navigation engineering, roads and highways).	2,518	8,421
Electrical Engineers	156	501
Mechanical Engineers	106	120
Architects	9	8
Other categories of technical personnel	115	32
TOTAL	2,904	9,074

It appears from the questionnaire that the minimum academic qualifications for the gazetted posts is a degree in civil engineering or its equivalent, and for non-gazetted a diploma or licentiate or equivalent qualification. Usually about 25 per cent. of Graduates in engineering are appointed to non-gazetted posts.

On the above basis the requirements may be further classified as :—

Graduates in civil engineering	4,625
Diploma holders or licentiates in civil engineering	6,314
Architects (graduates)	17
Gr aduates in electrical engineering	281
Diploma holders or licentiates in electrical engineering	376
Graduates in mechanical engineeriug	136
Diploma holders or licentiates in mechanical engineering	90
Post-Graduate degree holders in other scientific subjects	161
	12,000

Pattern of Employment and Training Facilities.

121. The bulk of personnel required for the Public Works Department are civil engineers. They fall into several distinct specialist groups *viz.* building and structural engineers. irrigation and hydraulic engineers, engineers qualified in design and construction of dams, highway engineers, railway engineers etc. These special groups become more prominent in the context of the development projects of the various departments. None of the department has classified its requirements into distinct specalist groups and since the higher posts are usually filled by promotion from lower ranks it follows that the personnel are administratively and technically interchangeable between various lines, for instance, from irrigation to dam construction or building construction, or from building and structures to highways etc. While it is beyond the scope of this report to discuss the merits or otherwise of this procedure, we feel, that it is necessary to point out that in every departments it will be necessary to have at least a few persons specially trained in special branches of civil engineering and that it is essential to make arrangements for field training of engineers in these special branches.

122. Most of the departments engaged on civil construction work have routine type facilities and they train their freshly recruited staff in these branches departmentally. Training facilities are also available in maintenance and general irrigation engineering, on projects already completed or under construction, such as the Mandi Hydro-electric project, the Jog falls projects, the Kishna Raja Sagar Project, the Ramapadasagar project etc. As a matter of fact, best training is imparted when the project is under construction. A large number of constructional projects like the Bhakra project. the Damodar Valley Project, the Kosi High Dam Project, the Hirakud Project etc. are likely to be taken in hand in the next 5—10 years. It would thus appear that a considerable number of engineers can be provided suitable training in high dam construction and irrigation problems.

The develcpment of national high-ways and improvement of Provincial roads will again offer good traning facilities for staff employed on highway construction.

The Central P. W. D. can trian a few engineers in air-conditioning technique. It may be pointed out here that facilities in this subject are not available easily.

The designs office under the CWINC can offer facilities in the training of a limited number of engineers in design work. We feel that experienced engineers from the provinces and states should be periodically deputed to this officer for experience in design work. The research organizations under the CWINC also offer very good training facilities in hydraulic engineering and the soil laboratories of the Madras Goverent and those now being organized by the United Provinces P. W. D. and the research laboratory planned by the Assam Government at Shillong can offer good training facilities in soil investigations, road works, irrigation and drainage works.

123. All the departments concerned have not stated the number of trainees they can absorb but they have in general stated that they usually provide training to the fresh staff recruited on the construction projects in hand. While this arrangements is working satisfactorily so far, we feel that it is absolutely essential for each department which possess as requisite training facilities to train more engineers than its normal requirements. As a result of our survey we are of the opinion that at least

400 engineering graduates can be trained in the various projects indicated above in such subjects as soil mechanics, hydraulic research, air conditioning technique, design and construction of dams building and structural engineering etc. The distribution of trainees amongst various branches should, we feel, be decided in consultation with the heads of the departments concerned and should be commensurate with the project in hand.

Training Abroad.

124. We discussed with the heads of the departments the need of training Indian personnel abroad and the subjects in which such training should be organized. All the heads of the departments felt that while existing facilities were quite adequate in certain respects, it was necessary to depute experienced members of their staff for specialized study in certain branches of civil engineering. We give below the number of persons to be trained abroad during the next 5 years. The information has been given by the departments :—

No. of Men.	Subjects.	Remarks.
Central P. W. D.—		
10 Engineers	Road construction and road administration.	Department deputes 2 members of its staff annually for trainig abroad.
CWINC		
4 Engineers	Design and construction of dams.	
2 engineers	Hydrology.	
2 Engineers	Navigation & river training.	
2 Engineers	Soil mechanics.	
3 Engineers	Hydraulic research.	
2 Engineers	Design of structures.	
East Punjab P.W.D. & Irrigation	Hydraulic Engineering	No. not stated.
United Provinces P.W.D.—		
60 Engineers	In R.C.C. works, bridge design and construction and town Planning.	
Orissa	Not necessary.	
Bihar—		
10 Engineers	Roads and Bridges.	
15 Engineers	Dams.	
10 Engineers	Water Supply.	
20 Engineers	Hydro-electric.	
Assam	Not nescessary.	
Bombay—		
19	Road construction, dams, hydrology, geology, and soil mechanics.	
C.P. & Berar—	Not necessary.	
Madras—		
25	Bridges construction.	
7	Cement concrete.	
2	Plant and machinery.	
46	Irrigation and Hydraulic Engineering.	
10	Municipal & Sanitary engineering.	
10	Building and structures.	
40	Design and construction of dams.	
Mysore—		
No. not stated	Irrigation and civil engineering.	
Travancore—		
20	Dam design, soil mechanics, highway construction, structural engineering.	
319		

125. It will be noticed that the total number of people to be sent abroad during the next five years *viz.* 319 is considerable. Whilst there is undoubted need for improving the knowledge of engineering science available in the country by organizing study tours for short period, we feel that it is not absolutely necessary to send staff abroad in such large numbers as has been stated by the departments concerned. In our opinion the training should be restricted to a few important fields in which training facilities in the country are very poor. In th se subjects in which adequate facilities are available experienced engineers may be sent abroad only for short study tours. The subjects in which it is essential to organize training abroad are design and construction of multipurpose projects on various rivers, with special reference to storage reservoirs for irrigation, power generation, navigation, soil mechanics and hydraulic engineering. In our opinion the training in design of multipurpose projects can be organized by selecting suitably qualified and trained personnel and associating them with designers abroad and providing them facilities to visit the important projects executed abroad. When actual construction of the projects is taken in hand it should be possible to train a verly large number of engineering graduates under the general supervision of foreign trained senior staff.

The Departments of Electricity.

126. The chief function of the electricity departments of the Governments is to promote the generation of electrical power, its transmission and distribution. The nationalization of electricity power generation is in progress and the small generating stations which are at present being run under private enterprise may be taken over by the Government in due course. This department, therefore, should become one of the largest public utility undertakings of the Governments and their activities would be responsible for a substantial part of the state revenue.

127. Under the Central Government there were two organizations for advising the Central, Provincial and State Governments on technical matters. These organizations have been amalgamated into one body known as the *Central Electricity Commission*. This body will coordinate the development of electric power in all provinces and states and will give advice on specific problems regarding generation and transmission of power. If necessary this organizaion will also prepare complete project reports and designs of generating stations and transmission lines.

128. All the Governments and states do not have a separate electricity department. In some governments this work is carried out by the Public Works Department. In this section we will consider the requirements of those governments who have a separate electrical department. The requirements of other governments have already been covered under the Public Works Departments.

Staff employed.

129. Technical staff employed in various Government departments is as follows :—

	Officers.	N.G.O.
Central Electricity Commission—		
Electrical Engineers	107	47 (includes other technical staff also).
PROVINCIAL DEPARPMENTS OF ELECTRICITY—		
C. P. & Berar—		
Civil Engineers	9	28
Hydraulic Engineers	6	14
Electrical Engineers	39	43
Madras—		
Civil Engineers	72	132
Mechanical Engineers	11	27
Electrical Enginneers	109	257

	Officers	N.G.O.
Mysore—		
Civil Engineers	6	12
Electrical Engineers.	69	500
Mechanical Engineers	7	25
Travancore Govt.—		
Civil Engineers	11	39
Electrical Engineers	27	147
Cochin Government—		
Engineers (Civil, mechanical and Electrical)	5	11
Jodhpur Govt.—		
Electrical Engineers	5	18

East Punjab No information has been received from the East Punjab Government.

The staff employed in these departments may be classified as :—

	Officers	N.G.O.
Electrical Engineers	356	1,012
Mechanical Engineers	18	52
Civil Engineers	98	211
Unclassified Engineers	11	25
	483	1,300

130. It would be noticed that the bulk of the staff consists of electrical engineers but the departe ments do employ a good number of civil and mechanical engineers. The former are employed for the construction and maintenance of dams, generating stations etc., and the latter for work in connection with the workshops, power plants etc.

Development programme.

131. We propose to consider here the development plants of the governments as have been made available to us but we will also consider an over all development of the electrical power generation in the country in a subsequent paragraph.

Orissa.

The province has large resources for the generation of hydro-electric power and plants have been drawn up to utilize the potential energy from the Mahanadi river and Duduma falls and Bogra falls. In the first stage this will develop 35,000 KVA and ultimately 75,000 KVA. The multipurpose development of the Mahanadi river on the model of TVA and the installation of thermal stations at Cuttack, Berhampur, Sambalpur and Balasore are contemplated to create an initial load for the big electrical projects.

C. P. & Berar.

Plans are being made for the installation of thermal power station and it is expected that the construction will be completed by 1952. The development and utilization of water power resources of the province is also receiving attention of the Government and preliminary survey of the river system has been conducted. The Government has tentatively approved of the Wainganga reservoir project scheme and have decided that a detailed survey should be undertaken.

Bombay.

The department has plans for developing its electric grid system.

Mysore Govt.

Extension of the Jog power scheme and installation of machinery for the generation of 72,000 KW and construction of transmission line and sub-stations are receiving attention. Other major schemes under consideration are Mekadatu Power Scheme to generate 24,000 KW, Lakkavalli reservoir power scheme generating 30,000 H.P. and Yennahole project generating 120,000 KW. Electrification of railways and introduction of electrical transport in cities like Bangalore and Mysore, and extension of rural electrification are also receiving attention.

Madras.

The schemes in hand are the Machkand Hydro Electric Scheme, the Moyar Hydro Electric Scheme, the Pykra Plant extension, the Papanasan Plant extension, the Nellore Thermal Station, the Madura Thermal Station etc. Here again electrification programme for rural areas and small towns, and acquiring the Madras Electric Supply Co. Ltd. and developing it on modern lines are under consideration.

Travancore Government.

The completion of the second stage in development of Pallivasal Hydro Electric Project (22,00 KVA) and the investigation relating to its 3rd stage development (15,000 KW) have been taken in hand Completion of the first and second stages of Sengulam hydro electric power station and construction of transmission lines and sub-stations are expected to be completed by about 1954. The Nariangulam Kallar Valley and Iddikki development schemes are also under investigation.

Cochin Government.

The Cochin Government will complete the firt stage of the Proingalkuthu hydro electric scheme (20,000 KW) during the next five years.

132. *We give below a consolidated statement of new projects which are under consideration of various governments :—

Name of Unit.	Name of Project.	Proposed installed Capacity in K.W.	Remarks.
Baroda States	Zankhari Project	2300	Construction of dam across the combined Zankhari & Gira valleys.
	Sabarmati Irrigation Project	6000	Construction of a dam across the Sabramati river.
Bengal	Gumti Dam Project	700	
	Somedwari Dam Project	10,000	
Bihar	Kosi valley Project	10,00,000	Under investigation by C.W.I.N.C.
Bingal & Bihar	Damodar Valley Project	300,000	This scheme provides for construction of 8 dam of various heights and lengths, across the Demodar and Barakar rivers and their tributaries and aims at flood control, irrigations generation of hydroelectricity navigation etc. under investigation.
Gwalior	Sind River Project	16,000	Irrigation scheme (with earthen dam for storage)
Jodhpur	Jawai irrigation & Hydel Project	4,500	
Madras	Ramapadsagar Project	75,000	Dam across Godavari under construction.
Mysore	(*a*) Bhadra scheme	17,000	
	(*b*) Cauveri Scheme	1,20,000	
	Hydro-Elec. Project at the Jogfalls.	(with a load of 120,000 KW.)	Under construction.
Orissa	The Mahanadi valley Project Machkund.	2,00,000	The project provides for construction of 3 dams on the Mahanadi river with 3 canals systems for irrigation. First dam will be at Hirakud and the others at Takkerapara and Niraj.

*Figures taken from the Journal "Engineering & Machine Tools (India)" Volume 1. No. 2 January 1948, Page 18 to 23.

Name of Unit	Name of Project	Proposed installed Capacity in K.W.	Remarks
Machkund	Hydro-Electric Scheme at Dumduma falls.	1,00,000	Jt. scheme of Madras and Orissa.
East Punjab . . .	The Bhakra Dam Project .	1,60,000	Dam across the Sutlej at Bhakra 200 miles. of lined canal with a net work of distributaries.
	The Nangal Power Project .	1,38,000	Construction taken in hand.
Rajputana States . .	The Chambal Hydro-electric scheme	1,50,000	
U.P.	The Sarda Hydro-electric Project.	41,000	
	The Nayar Dam Scheme .	1,00,000	Dam across Nayar, a tributary of the Ganges Construction is likely to start soon.
	The Rihand Hydro-electric project	1,50,000	Dam on the Rihand a tributary of the Sone. Irrigation will be done in Bihar.
	The Ramaganga Dam Project .	50,000	

Staff requirements

133. As mentioned earlier some electricity departments of the Governments are under the Public Works Department. In such cases the staff requirements have already been covered. Here we will only give the requirements of these departments of the Governments which are independent of the Public Works Departments and have stated their definite requirements. It would also be noticed that an overall development of hydro-electric power to generate 2·65 million KW is also contemplated Since power generation has been given top priority it may be assumed that these schemes will be taken in hand during the next 5-10 years. The staff requirements for the distribution of electrical energy and maintenance of power lines has been considered under a different section of this report,. namely engineering industries.

Central Electricity Commission

The staff required for the increased activity of the department as well as for replacement on accoun of retirement or wastage has been estimated as 71—all electrical engineering graduates. It is likely that if the activities of the department increase the staff may also be increased by another 25% during the next 10 years's period. Taking a broad view, therefore, we estimate the total requirements of this department would be about 117 electrical engineers.

Central Province & Berar

The development programme have already been initiated and some staff has already been appointed Additional requirements, however, are 27 officers and 43 non-gazetted officers. This includes civil, electrical and mechanical engineers but the number of electrical engineers is likely to be more than of one category.

Madras, Mysore, Travancore & Cochin

The staff required for the new construction projects and for replacement on account of retirement etc. has been estimated for this area as follows :—

	Officers	N.G.O.
Electrical Engineers	136	531
Mechanical Engineers	13	30
Civil Engineers	5	20
Jodhpur Government—		
Electrical Engineers	1	
Total staff requirements, therefore, are :—		
Electrical Engineers	254	531
Mechanical Engineers	13	30
Civil Engineers	5	20
Unclassified engineers	27	43
	299	624

Pattern of employment & training facilities

134. The minimum educational qualifications for all gazetted posts is usually a degree in engineering and for the non-gazetted staff a diploma or a licentiate's certificate. The higher posts are filled up by promotions from experienced staff and the bulk of recruitment takes place in the lower cadres. Assuming that about 25% of the non-gazetted posts in the electricity department will be filled by engineering graduates we may classify the above requirements as follows :—

Graduates in electrical engineering	414
Licentiates in electrical engineering	421
Graduates in Mechanical engineering	28
Licentiates in Mechanical engineering	30
Graduates in civil engineering	13
Licentiates in civil engineering	17
	923

135. All the electricity departments have good training facilities in power generation and distribution. These facilities will increase further as new hydro-electric schemes are taken in hand. In fact it is in the construction stage that the best training facilities are available. Some of the important concerns like the Calcutta Electric Supply Co., have also good training facilities. Generally speaking the heads of the departments contacted by us were in favour of providing training to fresh graduates and as far as we could ascertain, about 160 electrical engineers can be trained in the various electrical projects. But the actual number of trainees for whom training facilities can be provided is far more in all the electrical undertakings, both state-owned and private. The main difficulty however, is that the majority of engineering graduates are not financially in a position to undergo training as unpaid apprentices for a period of 2—3 years ; under the circumstances the number of students who obtain facilities for training for such periods are only those who are employed as junior or apprentice engineers by the Electricity Systems. The large majority of engineering graduates undergo training for short periods varying from 6 months to one year, depending upon the minimum period essential for them to qualify for a degree, in cases where such training is compulsory. To ensure that a larger number of graduates should take advantage of the training facilities, which would be afforded by the large number of projects under construction, it has been suggested that Training Stipends of suitable value should be instituted.

Training Abroad

136. The requirements of staff for training abroad in the next five years as indicated by the respective government departments are as follows :—

Bihar	10	Hydro-electric engineers.
	10	Electrical Engineers.
Assam		Not necessary.
Bengal	..	No information.
East Punjab	..	No information.
Central Electricity Commission	30	Design and operation of Thermal Power Stations, commercial methods like rate making, and training of engineers in the design and modern methods of construction of transmission projects and erection of large electric generating plants.
Bombay Government	..	It is not necessary to send any engineers from department for prolonged higher studies but the senior officers may be sent abroad for short study purpose.
Mysore Government	26	Training in manufacture of transformers, hydraulic prime movers, generators, insulators and cable making.

Travancore	85	Construction and testing of generators and other equipment commercial and administrative experience including traiff structure, design of protective system, design and construction of dams.
Cochin Government	10	Hydro Electric Engineering, Manufacture of switch boards and transformers etc.
Madras Government	..	Madras Government are making arrangements to send its experienced engineers for higher technical training abroad.
	171	

Department of Scientific Research.

137. The Government has recently created the Department of Scientific Research under the Hon'ble Prime Minister. The new Department will take over the work of the Board of Research on Atomic Energy and will advise Government Departments on scientific matters and will be concerned with the promotion of *ad-hoc* scientific research in Universities and Research Institutions, will be responsible for award of research scholarships in applied scientific subjects, and will deal with international scientific unions, Scientific Liaison Offices, Scientific Consultative Committee and such other subjects as may be transferred to it. The Department will also co-ordinate the scientific activities of other Ministries and in this work will be assisted by a Co-ordination Committee consisting of eminent scientists. The Department of Scientific Research will administer the Council of Scientific & Industrial Research, although the Council will retain its non-official character and will continue to function as before *i.e.*, with the Hon'ble Prime Minister as President of the Governing Body, the Director, Scientific & Industrial Research (Dr. Sir S. S. Bhatnagar, O.B.E., F.R.S. will remain the Principal Executive Officer of the Council and will also be the Secretary to the Government of India, Department of Scientific Research.

Organisation and Functions of the Council of Scientific and Industrial Research

138. On the outbreak of the war the need for establishing a Central Research Organization became more pressing than ever as much of the sources of supply of certain raw materials and finished products were cut off and many commodities essential for the prosecution of war were required to be produced in the country. The Board of Scientific and Industrial Research was therefore established by the Government in 1940. The Industrial Research Bureau which had been functioning since 1935 was amalgamated with the Board.

139. The experience gained in the working of the Board during the period 1940-42 suggested the necessity of enlisting the active support and co-operation of non-official agencies so that research development activities may proceed on the broadest possible basis. The Council of Scientific and Industrial Research was accordingly se up in 1942 as a Registered Society. The Government placed at the disposal of the Council and Industrial Research Fund with an annual non-lapsable grant of Rs. 10 lakhs for a period of 5 years in the first instance. This annual grant has now been considerably increased Rs. 38·5 lakhs for 1948-49).

The aims and objects of the Council are :—

(i) Promotion, guidance and co-ordination of scientific and industrial research in the country.

(ii) Establishment and development of special institutions as well as development of existing institutions, for scientific study of problems affecting industry and trade.

(iii) Establishment, maintenance and management of laboratories, workshops, institutes and organisations to further scientific and industrial research.

(iv) Collection and dissemination of information in regard to research, and development of a industry.

(v) Publication of scientific papers and journals on industrial research and development.

The Council has two standing advisory committees, *viz*, the Board of Scientific and Industrial Research and the Industrial Liaison Committee. The Board is composed of eminent scientists and representatives of Government Departments and Industry and is assisted in its work by 22 Research Committees covering a wide field of scientific and research activities of the country. The research Committees of the Board examine and report on the progress of various research schemes, recommend necessary grants and formulate a co-ordinated schemes for further research. At present about 145 research schemes are being financed by the Council at various Universities and Research Institutions and provide post-graduate training and employment to 270 research workers in various scientific fields.

The Industrial Liaison Committee advises on the ways and means of commercial utilisation of the industrial processes evolved through laboratory investigations, carried out under the auspices of the Council. Nearly 43 processes have been leased out to the industry for commercial exploitation. Some more are waiting to be leased out. However, by far the largest number of processes developed during the war having direct bearing on defence of the country were made available to the Defence organisation of the Government. The practice of protecting results of industrial research through patents has been followed by the Council. More than125 inventions evolved by the research workers of the Council have formed the subject matter of patents, sealed or pending. A few patents have also been taken out in foreign countries.

Activities relating to commercial exploitation of Council's precesses, which is the main function of the Committee, have now been transferred to the control of the Ministry of Industry & Supply.

140. The Council itself has laboratories, which are at present temporarily housed in the buildings of the Delhi University. In the short period of their existance a considerable amount of valuable work has been carried out on the development of substitutes and utilisation of indigenous materials for industrial purposes. The Council is also compiling a Dictionary of the Economic Products and Industrial Resources of India. When complete it will comprise sections on naturally occuring and cultivated medicinal plants, forest products, animal products, minerals and chemical industry. First volume of the Dictionary comprising articles beginning with letters A & B is ready and will be published soon. A monthly journal entitled the "Journal of Scientific and Industrial Research" is published by the Council and contains articles of general industrial interest as well as scientific papers on scientific researches. The growth in the circulation of the Journal has been very satisfactory and the number of copies now under circulation exceed 1,500.

141. *National Laboratories.*—In 1942 the Government of India sanctioned a capital grant of Rs. 1 crore to be made available after the termination of war for the establishment of a number of National Laboratories to cover various fields of scientific activity. Plans have already been drawn up for the establishment of the National Physical Laboratory, the National Chemical Laboratory, the National Metallurgical Laboratory, the Central Glass & Ceramic Research Institute and the Fuel Research Institute. The construction of buildings for these National Laboratories has been taken in hand and the buildings are in various stages of completion. Detailed plans for the establishment of the Road Research Institute have been drawn up but the construction of buildings for the Institute have not been undertaken yet. Plans have also been approved for the establishment of the Building Research Station at Roorkee and a sum of Rs. 5 lakhs has been made available to start work at the premises of the Thomason Engineering College. Directors have been appointed for the National Physical Laboratory, the National Metallurgical Laboratory, the Fuel Research Institute, and scientific work on a limited scale has already commenced in some of these laboratories.

Recently the Government has approved of the establishment of the Central Leather Research Institute, the Central Electro-Chemical Research Institute and the Central Drug Research Institute. Foundation stones of two of these laboratories (Leather & Electro-Chemical Research Institutes) have been laid recently. It is understood that proposals for the establishment of a Central Technological Food Research Institute are under consideration of the Government and a Planning Officer has been appointed to work out the detailed scheme. Officers have also been appointed to prepare plans for other institutes and work in this connection is being expedited with the greatest speed.

We would like to mention here that donations to the value of Rs. 20 lakhs have been received by the Council from the House of Tatas as a part contribution towards the establishment of the National Metallurgical Laboratory and the National Chemical Laboratory and of Rs. 15 lakhs from Dr. Sir Rm. Alagappa Chettiar towards the establishment of the proposed Central Electro-Chemical Research Institute and of about Rs. 2 lakhs from other donors.

142. *Staff employed.*—Staff employed by the Council at present consists of :—

	Senior Scientists with post graduate Research degrees	Junior Research Scientists	Non-Departmental Research Scholars
Chemists:			
Inorganic & General	2	5	
Organic	4	12	
Physical	3	2	
Applied Chemists	3	29	
Biochemists	1	2	90
Physicists	6	10	69
Biological Scientists	2	8	2
Metallurgists	2	1	1
Geologists	1	..	
Fuel Technologists	2	..	
Furnace Technologists	1	..	
Engineers Civil	1	1	
Mechanical	1	2	
Electrical	..	1	2
Roads	1	..	
Draftsmen	..	3	
Patent Assistant	1	..	
Unclassified	..	..	75*
	31	76	239
Total	346		

143. *Development : Programme Department of Scientific Reseaarch*

In view of the growing realisation that development of the country is intimately related to and dependent on the use of scientific knowledge and its application, we expect that the activities of the Department of Scientific Research will increase considerably. Recently the Government has also constituted an Atomic Energy Commission to advise the Government on various matters relating to research and development of atomic energy. This Commission will work under the chairmanship of Dr. H.J. Bhabha, F.R.S., and its members are Sir K.S. Krishnan F.R.S., and Sir S.S. Bhatnagar, F.R.S. (Member-Secretary). Technical staff is being appointed shortly for research as well as for technical-cum-administrative duties.

Council of Scientific and Industrial Research

The general line of development envisaged by the Council relates to an early functioning of these laboratories on full scale and the establishment of laboratories covering other fields of scientific activity which have not so far been covered. For instance, the Internal Combustion Research Committee of the Council of Scientific & Industrial Researeh has recommended that a National Internal Combustion Engineering Laboratory be established. This recommendation is under the consideration of the

*Staff employed by research institutions receiving Block Grant from the Council.

authorities and work in connection with the establishment of the laboratory will be undertaken shortly. As mentioned earlier planning work for the Central Electro-Chemicals Research Institute, the Drugs Research Institute, the Central Leather Research Institute and the Central Food Technological Research Institute has geen undertaken.

One of the most notable activities of the Council, namely giving grants-in-aid to research institutions and financing research schemes has been on the increase during the last 3 years. The amounts spent on latter account were :—

Rs. 7·84	Lakhs	in	1945-46
Rs. 8·40	"	in	1946-47
Rs. 14·25	"	in	1947-48

The Council has so far given grants to the following research institutions :

1.	Tata Institute for Fundamental Research	Rs. 2·1 lakhs.
2.	Calcutta University	Rs. 1·5 "
3.	Bombay University	Rs. 1·0 "
4.	Madras University	Rs. 1·2 "
5.	Research Laboratory of the Indian Academy of Sciences (Capital grant)	Rs. 3·0 "

We may infer that the Council's activity in financing research schemes will increase further during the next 5 years. In the light of our previous years' experience we estimate that abourt 24 new research projects are likely to be sanctioned annually during the next quinquennium. These research schemes will enable about 250 scholars to conduct research. We are, however, not in a position to make a forecast of the likely distribution of the research projects amongst the various sciences.

The Council has been advocating the estabishment of cooperative research associations and laboratories by the industry. One such cooperative research institute is being planned by the Ahmedabad Textile Industry Research Association. The preliminary planning work has been completed and the association now proposes to undertake scientific investigations in temporary laboratory premises. It is understood that the Government will also contribute towards annual recurring expenditure of this institute.

It has also been reported recently that textile millowners in Coimbatore have formed a Research Association and are contemplating the establishment of Textile Research Laboratory in Coimbatore.

Attempts are being made to establish Research Associations for Leather, Chemicals, and Pharmaceutical Industries and it is hoped that these associations may start functioning soon. It is likely that the Council's activity in this respect will increase considerably in the near future. We are, however, not in a position to assess at this stage the requirements for personnel for these cooperative enterprizes.

144A. We would like to mention here that there are two other Government sponsored research organisations *viz.*, the Indian Council of Agricultural Research and the Indian Research Fund Association. Their activites are described in chapters under Agricultural Departments and Medical and Public Health Organisations.

145. Sometime ago the Government set up a number of Industrial Panels to advise them on the Industrial development of the country. In their reports the panels have recommended the establishments of research Institutes for work on woollen textiles, cellulos, rayons, hosiery, leather, paints, etc. It is not known at present whether recommendations in this respect will be given effect to during the next five years. We, however, assume that developments will be favourable. As work for planning, construction, and equipping each of these research institutions is likely to take some time, we are of the opinion that it would be desirable to make an early start towards their establishment. It is also necessary that provision for the training of highly specialised staff for these institutions be initiated soon.

146. *Staff requirements.*

DEPARTMENT OF SCIENTIFIC RESEARCH.

The requirements for the Department may be stated as :

(a) for Research Work.		These may be classified as :—	
Physicists	10	Physicists	11
Chemists	10	Chemists	11
Geologists	10	Geologists	11
Administrative (Technical)	3		

(*b*) for technical-cum-administrative work :—

Deputy Secretary	2	These may be apportioned as:—
Under Secretary	1	Chemists 3
Assistant Secretary	1	Physicists 3
Scientific Officer	4	Engineer 1
	(Tentative)	Geologist 1

C. S. I. R.

We give below the estimates for staff requirements as worked out by Planning Committees appointed for various National Laboratories.

National Physical Laboratory :—

Director	1
Assistant Directors	10
Senior Research Officers	13
Junior Research Officers	18
Research Assistants	56
Mechanics, Electricians	41

National Chemical Laboratory :—

Director	1
Assistant Directors	7
Senior Research Officers	18
Junior Research Officers	25
Research Assistants.	64
Tech. and Workshop Staff	35

National Metallurgical Laboratory :—

Director	1
Asstt. Directors	5
Research Officers	7
Junior Research Officers	15
Research Assistants	28
Workshop Staff	25

Central Glass & Ceramic Research Institute :

Director	1
Research Officers	9
Research Assistants	20
Workshop Staff	7

Fuel Research Institute :—

Director	1
Asstt. Directors	6
Research Officers	26
Research Assistants	23
Workshop Staff	13

Field Stations of the F.R. Institute :—

Scientific staff for 5 stations	80

Road Research Institute :—

Director	1
Asstt. Directors	
Research Officers	21
Research Assistants	28
Workshop Staff	25

Building Research Station :—

Director	1
Research Officers	27
Research Assistants	34
Technical and Workshop Staff	22

147. Planning Committees for the proposed Central Drugs Research Institute, Central Leathers Research Institute and the Central Electro-Chemicals Research Institute and other proposed institutes are being constituted. Considering the scope of work to be conducted at these laboratories we place below our tentative estimate for staff requirements as follows :—

Central Drug Research Institute.—

Director	1
Asstt. Directors	14
Research Officers	17
Research Assistants	27
Tech. Workshop Staff	52

CENTRAL LEATHER RESEARCH INSTITUTE.

General and Physical Section :—

Director	1
Assistant Director	1
Scientific Assistants	4

Organic Section :—

Assistant Director	1
Scientific Assistants	4

Biochemical Section :—

Assistant Director	1
Scientific Assistants	4

Analytical Section :—

Assistant Director	1
Scientific Assistants	4

Tanning Section :—

Assistant Director	1
Scientific Assistant	1
Foremen	4
Technical staff for workshop	25

(Figures taken from the proposal submikted by Mr. K. S. Chowdhury to the Council)

Central Electro-Chemical Research Institute. :—

Director	1
Heads of Division of Electro-chemicals (organic & inorganic)	3
Research Officers	18
Research Assistants	20
Technical & Workshop staff	35

Central Food Technological Research Laboratory :—

Director	1
Assistant Directors	6
Research Officers	19
Research assistants	38
Tech. & Workshop Staff	13

National Internal Combustion Engineering Laboratory.

Director	1
Heads of division of Metallurgy, Engineering, testing and standardization certification and fuel	5
Research Officeres	20
Research Assistants	25
Technical & Workshop staff	50
Approximate staff requirements for Research Schemes	250
(may be apportioned tentatively as	
Chemists	150
Physicists	75
Engineers	25)

148. The total staff requirements for the Department of Scientific Research & the National Laboratories comprise 1089 scientific personnel and 343 technical and workshop staff. The staff employed at present in the Council's Laboratory at Delhi & Planning staff employed at other National Laboratories number 63. (excluding research scholars). We anticipate that this staff will be absorbed in the National Physical and the National Chemical Laboratories. Additional staff to be recruited in the course of next 5 years or so is about 1026 scientific and 330 technical workshop personnel.

149. We have also made tentative estimates for the research staff that may be needed for research laboratories recommended by the Industrial Panels. These are :—

1. *Central Research Institute for Woollen textiles* :—

(a) Sheep rearing	Director	1
	Veterinary Expert	1
	Animal Husbandry	1
	Research Assistants	12
(b) Shearing	Mechanical Engineering	1
	Animal Husbandry	1
	Research Assistants	2
(c) Sampling, grading, blending	Textile engineer	1
	Research Assistants	2
(d) Preparation, spinning and weaving	Textile technologist	1
	Textile Engineer	1
	Research Assistants	2
(e) Bleaching, dying & finishing	Textile chemist	1
	Engineering	1
	Research Assistants	2
(f) Testing, standardization, physical & chemical properties.	Textile expert	1
	Chemist	1
	Physicist	1
	Research Assistants	6
(g) Textile Engineering	Engineer	1
	Research Assistants	2
(h) Technical staff for workshop		20
REGIONAL RESEARCH STATION FOR WOOL		
(1) Spinning & Processing	Officer-in-charge	1
	Engineer	1
	Chemist	1
	Physicist	1
	Research Assistant	3
(2) Feeding, breading etc.,	Officer-in-charge	1
	Animal Husbandry	1
	Agricultural economist	1
	Pathologists	2
	Research Assistants	8

Rayon Research Institute.

(*a*) Sampling & Blending	Director	1
	Textile technologist	1
	Textile Engineer	1
	Research assistants	2
(*b*) Preparation, spinning and weaving	Textile technologist	1
	Textile engineer	1
	Research Assistants	2
(*c*) Dyeing & Finishing	Textile chemist	1
	Engineer	1
	Research Assistants	2
(*d*) Testing, chemical and Physical Properties, Pulp etc.	Chemists	2
	Physicist	1
	Engineer	1
	Research Assistants	8
(*e*) Textile Engineering	Engineer	1
	Assistants	2
PILOT PLANTS (PULP)	Chemist.	1
	Engineer	1
	Assistants	2
PILOT PLANTS (RAYON)	Organic Chemist	1
	Physical chemist	1
	Engineer	1
	Assistants	3
	Tech. Staff for workshop	25

3. *Hosiery Research Station.*

(*a*) Spinning, realing and preparation	Officer-in-charge	1
	Textile technologist	1
	Textile engineer	1
	Research Assistant	2
(*b*) Bleaching & finishing	Textile chemist	1
	Textile expert	1
	Research Assistants	2
(*c*) Textile Engineering	Engineer	1
	Research Assistants	2
(*d*) Supervisor for training		1
Tech. staff for workshop		10

4. *Central Research Institute for Silk.*

(*a*) Mulbarry Cultivation	Director	1
	Agricultural	1
	Scientist, Botanist & Entomologist	2
	Research Assistants	2
(*b*) Rearing of silk worms, study and control of diseases.	Biological Scientist	1
	Entomologist	1
	Pathologist	1
	Research Assistants	12
(*c*) Opening, cleaning & Carding	Textile technologist	1
	Textile Engineer	1
	Research Assistants	2
(*d*) Blending, preparing and spinning	Textile Technologist	1
	Textile Engineer	1
	Assistants	2
(*e*) Weaving & Spinning	Textile Technologist	1
	Textile Chemist	1
	Research Assistants	3
	Engineer	1
(*f*) Bleaching, dyeing and finishing	Textlile chemist	1
	Engineer	1
	Research Assistants	2

(g) Testing, standardization, general chemical and physical.	Chemist	1
	Physicist	1
	Engineer	1
	Research Assistants	3
(h) Textile Engineering	Engineer	1
	Research Assistants	2
(i) Utilization of wastes and bye-prodicts	Chemists	2
	Research Assistants	2
	Technical staff for workshops	35

5. *Paint Research Laboratory.*

(a) Raw Materials	Director	1
	Inorganic Chemists	3
	Research Asistants	3
(b) Preparation, ore dressing, grinding, mixing etc.	Chemists	2
	Engineers	2
	Research Assistants	4
(c) Chemical Division	Oil Technologist	1
	Organic Chemist	1
	Analytical Chemist	1
	Research Assistants	3
(d) Physical Division	Physicists	3
	Research Assistants.	3
(e) Production Engineering	Engineer Mechanical	1
	Engineer Chemical	1
	Research Assistants	4
	Technical staff for workshop	25

6. *Co-operative Research Institute for coir Industry.*

(a) Husk Treatment	Director	1
	Botanist	1
	Chemist	1
	Research Assistants	2
(b) Fibre Processing	Textile Chemist	1
	Textile Engineer	1
	Research Assistants	2
(c) Standardizing, chemical & Physical Testing etc.	Engineer	1
	Chemist	1
	Physicist	1
	Research Assistants	3
(d) Engineering Section	Engineer	1
	Chemist	1
	Physicist	1
	Research Assistants	3
(e) Training Supervisor		1
Technical staff or workshop		25

7. *Central Research Institute for Vanaspati.*

(a) Raw Materials	Director	1
	Oil Technologist	1
	Organic Chemist	1
	Research Assistants	3
(b) Chemical & Analytical testing	Chemist	1
	Assistant	1
	Physicist	1
	Research Assistant	1
(c) Engineering	Mech. Engineering	1
	Electrical Engineering	1
	Chemical Engineering	1
	Research Assistants	3
	Technical staff for workshop	20

8. *Textile Research Institute*

The proposed Textile Research Institute is being planned under the auspices of the Cotton Textile Fund Committee. A sub-Committee has been appointed to formulate detailed proposals for the proposed Textile Research Institute. It has been decided by the C.T.F.C. that one Deputy Director and one Assistant Director (Planning) should be recruited to work out the details of the scheme in collaboration with an expert committee. The Sub-Committee has suggested that the work of the institute be carried out through the following sections, and the staff requirements shown against each have been recommended. Further it has been suggested that the person appointed for planning work should work out the details in collaboration with members of the Sub-committee on the lines of the scheme drawn up for the National Physical Laboratory.

(a) Ginning and pressing Section	Director	1
	Asstt. Director	1
	Scientific Asstt.	3
(b) Opening, cleaning blending (c) Carding, combing (d) Spinning and preparation	Dy. Director	1
	Asstt. Director	3
(e) Winding, warping and spinning (f) Doubling and yarn packing (g) Weaving and Sizing	Deputy Director	1
	Assistant Director	3
(h) Dyeing, bleaching & finishing	Deputy Director	1
	Asstt. Director	1
(i) Materials (Physics & Chemistry Section dealing with fibres, yarn and fabric)	Asstt. Director	2
	Scientific Assistant	12
	Statistician	1
(j) Textile Engineering (to deal with maintenance, alteration & Improvement, and fundamental research on Engineering Problems).	The staff required has not been decided by the Sub-committee. Probable requirements, however, may be estimated at	
	Engineers	3
	Research Asstt.	3

In regard to Ginning and pressing section, the Sub-Committee was of the opinion that 4 Sub-Stations be established at Khanewal, Bombay, Akola and Coimbatore to deal with ginning and pressing conditions in out-stations. For 3 Stations the staff requirements may, therefore, be estimated at............12.

Note.—The number of the Scientific and Research Assistants in the divisions of spinning, weaving dyeing etc. i. e. (b) to (h) above has not been recommended. Following the example of N. P. L. it may be assumed that additional assistants required for these sections will be about..........................15. Technical staff for workshop 35

9. National Steam Power plant Laboratory
10. National Internal Combustion Plant Laboratory
11. National Hydraulic Power Plant Laboratory

The prime Movers Panel has recommended the establishment of these three National Laboratories, and also similar institutes for the Defence Services. Proposals have been made by the Indian Institute of Science Bangalore to the relevant Research Committees of the Council of Scientific and Industrial Research for the establishment of :—

(i) Power Engineering Department.

(ii) Internal Combustion Engineering Department.

at the Indian Institute of Science, Bangalore. The proposals have been accepted and the departments have started functioning. Additional staff requirements as reported in the memorandum on the proposals is as follows :

(i) Head of the power Engineering Department		1
(a) Electrical Division	Professors	2
	Asstt. Prof.	3
	Lecturers	3
	Tech. Asstts.	3
(b) Mechanical & Thermal	Professor	1
	Asstt. Professor	3
	Tech. Asstts.	2

(c) Hydraulic	Professor	1
	Asstt. Prof.	3
	Lecturer	1
	Tech. Asstts.	4

(ii) Prof. of the Internal Combustion Engineering Department	1
Asstt. Professor	1
Lecturers	2
Research Assistant	1

Staff already employed is not reported in these lists.

It is, however, understood that in the Internal Combustion Engineering Department, only research students have been addmitted as the buildings could not be completed in time for the admission of students in this session. The staff if not appointed will be appointed soon.

12. The Ahmedabad Textile Industry's Research Association proposes to appoint the following staff for their Research Laboratory :—

Director	1
Secretary	1
Deputy Secretary	1
Assistant Secretary	1
Scientific Officers	15

The staff may Comprise of :—

Applied Physicists	4
Textile Chemists	5
Textile Technologist	10

13. On similar considerations, staff requirements for the proposed Textile Research Association Laboratories at Coimbatore may be tentatively estimated as :

Applied Physics	4
Textile Chemist	5
Textile Technologist	10

The total scientific staff required for these laboratories recommended by the Industrial Panels adds upto 374 scientific and 195 technical personnel for workshops. We estimate that out of the latter at least 10% will be diploma holders in mechanical electrical engineering.

150. Keeping in view the work that will be carried out in the National and other research laboratories listed above, we classify the total staff requirements as :—

Physicists :—

General & applied	166
Electricity	31
Optics	14
Heat & Power	19
Electronics	15
Pyrometry	3

Chemists :—

Inorganic and General	273
Organic	91
Physical	62
Electro chemist	32
Analytical	62
Biochemists	44
Textile chemists	29
Mathematicians & Statisticians	17
Agricultural sciences	24
Animal Husbandry & Veterinary Experts	13
Biological sciences	23
Metallurgists	39
Fuel Technologists	32
Glass & Ceramic Technologists	8
Oil Technologists.	6
Textile Technologists	46
Geoloigsts	35
Leather Technologists	4

Engineers:

Civil	30
Mechanical	90
Electrical	33
Chemical	46
Mining	4
Hydraulic	12
Buildings	4
Roads	20
Automobile	12
Aeronautical	10
Textile	51
Diploma Holder (Mech)	53
Total	1453

Considering the nature and scope of work in the National Laboratories the Scientific staff shown above should have post graduate qualifications and research experience and the engineering and technological staff should have degree as the minimum educational qualification.

(Out of a total of 525 technical workshop staff we may assume that at least 10% i.e. 53 will hold diplomas in mechanical/electrical engineering).

Training Facilities

151. The training facilities that would be available at a subsequent period at these research institutes have been considered elsewhere in the report (Section on Scientific Research and Higher Education).

Training Abroad :

152 We give below the number of scholars who have to be trained abroad in various scientific fields as stated by the organisations. The subject of study have been suggested by the department and cover 5 years requirements :

Road Research Institute	7	Organization of road research, road safety experimental field work and road construction.
National Chemical Laboratory	20	Chemistry of high polymers, organic synthesis catalytic research reactions, chemical engineering etc.
National Physical Laboratory	83	Methods of testing standardization and certification and design of instruments etc.
Fue lReserach Institute	40	Coal carbonisation, gasification, high pressure reactions, polymerisation and combustion of fuel etc.
	150	

The number of persons to be trained abroad for other National Laboratories cannot be stated at present. It may, however, be added that the Council is fully alive of the necessity of deputing their staff abroad and has already sent some officers for advanced training in particular subjects.

It will be noticed the total number of persons to be sent abroad in five years is fairly high viz. 171. We feel that facilities are available in the country for training in certain subjects and that full advantage should be taken of the available facilities. Organized training abroad should be restricted to such subjects in which adequate facilities are not available in this Country. These subjects are design & operation of high pressure steam thermal power stations, design & modern methods of Construction of transmission projects & election of large electric generating plants etc., electric traction and building of electric locomotives, construction and testing of hydraulies prime movers, electrical generators and switch gear etc. One also important fields in which Indian personnel have to be trained abroad, but these appropriately come under Electrical Industry. The deputation of senior experienced staff for short tours abroad should be limited as far as possible and should be confined to a study of those subjects for which adequate facilities are not available. If a comprehensive report prepared by a visiting officer

could be made available to interested departments it would, in our opinion, help to contribute towards dissemination of technical information and obviate the necessity of sending people abroad for the same subject.

Government sponsored research Organizations

Industries, Supplies & Development Organizations

153. The activities of the Departments of Industries & Supplies comprise promotion of general development of large scale and cottage industries. These are described in details in paragraphs below. The data regarding the staff employed are given and the personnel requirements have also been assessed.

Ministry of Industry & Supply.

The functions of the Ministry of I. & S. are carried through the following offices:—

(1) Directorate General of Industries & Supplies, New Delhi.

(2) Directorate General of Disposals, New Delhi.

(3) Chief Technical Adviser (Fertiliser Project), New Delhi.

(4) Coal Commissioner, Calcutta,

(5) Iron & Steel Controller, Calcutta.

(6) Contoller of Patents & Designs, Calcutta.

(7) Officer-In-Charge, Central Sericultural Research Station, Berhampore, Bengal.

(8) Superintendent, Mathematical Instruments Office, Calcutta.

(9) Textile Commissioner, Bombay.

(10) Director of Industrial Statistics, Simla.

(11 Newsprint Officer, Simla.

(12) Salt Controller, New Delhi.

The biggest unit among the above offices is that of Directorate General of Industries & Supplies. The Directorate General of Industries & Supplies is divided into the following distinct Wings for the performance of duties and functions detailed hereinafter. Each of these Wings is in the charge of a senior officer directly responsible to the Director General of Industries & Supplies for the due performance of the function and duties allotted to that Wing :—

(1) Administration & Co.-ordination Wing under the Director of Administration & Co.-ordination.

(2) Development Wing under the Deputy Director General Development (Chemicals, Drugs & Plastics, etc—.)

(3) Development Wing under the Deputy Director General Development (Engineering).

(4) Supplies Wing under the Deputy Director General (Supplies).

(5) Inspection Wing under the Deputy Director General (Inspection).

(6) Government Test House.

The functions and activities of the Directorate General of Industries and Supplies are briefly stated as below :

(*a*) To act in consonance with the Stores Purchase Rules framed by the Govt. of India as a purchasing and inspection agency and in an advisory capacity on all matters connected with the purchase of stores on behalf of all Departments of the Central Government and minor local Administrations and of such Provincial Governments, State Rlys., Corporation, Port Trusts, Municipalities and similar quasi-public bodies, Universities and Indian States as may desire to avail themselves of its services.

(*b*) To scrutinise all indents for stores stated to be required from overseas countries and to pass the same on to the Government of India's purchasing agencies in the U.K. and U.S.A. in case goods of suitable quality are not procurable in this country at reasonable prices or within the period they are required to be brought into use. In the latter instanc it is the function of the Development Wing to examine and develop capacity to meet feuture demands in this country if the demand is sufficient and recurring to justify it.

(*c*) To inspect stores purchased direct by any Government Department, Railways, quasi-public Bodies, Indian States and private parties, in India as may desire to avail themselves of the facilities offered by the Directorate General.

(*d*) To carry out laboratory tests, analysis, etc., on behalf of the authorities referred to in the preceding Clause.

(*e*) To draw up for the approval of Departments which effect purchases through the agency of this Directorate General, specifications of the various Classes of stores in demand, and if so desired, to advise and assist Departments which make their own purchases in the preparation of specifications and laying down of standards.

(*f*) To act as a Central Bureau of Information on all matters relating to development of industries and purchase and inspection of stores and their prices particularly with reference to Indian manufactures. In the latter instance it shall be the function of the Development Wing to examine and develop capacity to meet future demands in this country if the demand is sufficient and recurring to justify it.

Development Wing of Directorate General, Industries & Supplies.

154. Planning work in connection with the improvement of established industries and development of New Industries is carried out by this Wing through a number of Directorates, each dealing with one particular industry or group of industries. The work of the Directorates is technical-cum-administrative and also includes assistance to industrialists in obtaining controlled indigenous raw materials, and import ing licences for basic raw materials, making recommendations on capital issues, collaborating with Tariff Board in their investigations on various industries, fixation of export quota and giving technical advice to industries regarding various production difficulties. The Wing has drawn up short term and long term plans for the development of indust ies which were discussed at the Industries Conference in 1947.

Staff Employed

155. We give below the Technical Staff employed by the following organisations :—

I.—*Ministry of Industry & Supply.*—(*a*) Directorate General of Industries & Supplies

(*i*) Supplies Wing

(*ii*) Inspection Wing

(*iii*) Development Wing

(*iv*) Government Test House.

(*b*) Directorate General of Disposals

(*c*) Textile Commissioner

(*d*) Iron & Sreel Controller

(*e*) Coal Commissioner

(*f*) Sindri Fertilizer Project

(*g*) Patent Office

(*h*) Mathematical Instrument Office.

II.—*Ministry of Agriculture.*

Indian Central Cotton Committee.

III.—Departments of Industries of Provinces & States.

Name of the Organisation	Sraff Employed	G.O.	N.G.O.
(a) (i) Supplies Wing of the D.G.I & S.	Chemists	4	..
	Physicists	1	..
	Engineers	26	5
	(Permanent strength of the Dept. is yet to be fixed.)		
(ii) Inspection Wing of the D. G. I. & S.	Chemists	2	31
	Civil Engineers	28	39
	Mech. Engineers	65	99
	Electrical Engineers	10	27
	Chemical Engineers	1	4
	Metallurgists	28	63
	Textile Technologists	20	73
(iii) Development Wing (Chemicals, Drugs & Plastics) of D.G.I.& S.	Chemists	16	
	Agricultural Science	1	
(iv) Development Wing (Engineering) of D.G.I.& S. Mech. Engineering Development Dte.	Engineers	4	
	Physicists	..	1
	Chemists	..	1
	Agri. Science Graduate	..	..
Electrical Engineeeing Dev. Dte.	Engineer	1	..
	Natural Science Graduate	..	1
	Physicists	..	2
	Agricultural Science	..	1
Metal Development Directorate	Metallurgists	2	..
	Physicists	1	..
	Chemists	..	1
Tools Development Directorate	Mech. Engineers	1	2
	Metallurgists	1	..
	Chemists	..	1

(It is understood that scientific staff employed in other division is about *25*. Their classification, however, is not known)

(iv) Govt. Test House	Chemists	26	..
	Applied physicists & Engineers	20	..
(b) Directorate General of Disposals	Physicists	26	
	Biologists	4	
	Engineers	33	
	Medical Graduate	1	
(c) Textile Commissioner	Physicists	4	
	Chemists	2	
	Mathematicians & Statisticians	10	
	Metallurgists	1	
	Biologists	3	
	Civil Engineers	1	
	Mech. Engineers	1	
	Electrical Engineers	1	
	Textile Technologists	25	
(d) Iron & Steel Controller	Engineers	6	
	Mathematicians & Statisticians	2	
	Physicists	1	
(e) Coal Commissioner	Mining Engineers	58	
	Fuel Technologists	12	
	Elec. Engineers	6	
	Medical Graduates	8	
(f) Sindri Fertilizer Project	Chemical Engineers	7	11
	Engineers (Mech. Elec. and Civil)	15	60
	Physicists	1	
(g) Patent Office	Physicists	7	
	Chemists	6	
	Engineers	8	
	Textile Technologists	1	
	Chemical Engineer	1	
	Metallurgists	1	
(h) Mathematical Instrument Office	Physicists	17	17
	Chemists	11	11
	Mathematicians & Statisticians	12	12

Name of the Organisation.	Staff employed	G.O.	N.G.O.
Mathematical Instrument Office.—*contd.*			
Indian Central Cotton Committee	Physicists	1	3
	Chemists	1	20
	Mathematicians & Statisticians	..	..
	Biologists	1	3
	Engineers	1	3
	Medical Science	1	2
	Engineers (Civil)	2	..
	Engineers (Mech.)	..	6
	Engineers (Elect.)	..	3
Indian Standards Institution	Physicists	1	1
	Textile Engineers	1	1
	Depts. of Industries of some Provinces & States.		
Delhi Province	Chemists	..	1
Drug Research Laboratory, Jammu	Chemists	3	12
	Medical personnel	2	2
Northern Indian & Rajputana States Jaipur	Chemists	2	..
	Statisticians	1	..
	Agricultural Science	2	..
	Mech. Engineers	1	..
Patiala State	Chemists	2	3
	Mechanical Engineers	1	..
East Punjab & U.P.	No information available.		
West Bengal	Mech. Engineers	18	2
	Electrical Engineers	13	2
	Medical Science	1	..
	Physicists	..	4
	Chemists	..	19
	Zoologists	..	3
Orissa	Mechanical Engineers	7	11
	Civil Engineers	3	10
	Electrical Engineers	1	..
	Agricultural Engineers	5	..
	Mathematicians	2	..
	Esturaine Biologists	4	16
Mayur Bhunj State	Civil Engineers	2	..
	Electrical Engineers	1	1
	Mining Engineers	3	..
	Ceramic Technologists	1	..
	Agricultural Sciences	1	7
	Chemists	2	..
C.P. Berar & Bombay Presidency	Physicist	2	41
	Chemists	2	10
	Mathematicians & Statisticians	1	3
	Engineers (Civil)	..	5
	Mech. Engineers	4	39
	Electrical Engineers	3	12
	Textile Technologists	3	5
	Chemical Engineers	2	..
	Leather & Tanning technologists	2	2

Madras, Mysore and Travancore.—The staff employed has already been covered under various industries which have been discussed in the industries section of the report.

156. The development of Inspection Wing of the Ministry of Industry and Supply is not independently visualised but since it is intimately connected with the development of industry its expansion in future will be correspondingly co-related.

157. The development programme of the Development Wing of D. G. I. & S. in general relates to working out of plans for the development and expansion of various industries like manufacture of diesel engines, ship building, automobiles, b cycles, hurricane lamps, industrial machines, transformers, storage batteries, electrical lamps and other domestic electrical appliances, heavy electrical power plant, wireless industry, cables, insulators and refractories, abrasives, beltings, ferrous and non-ferrous metals and alloys, machine tools etc. Since the development of these industries has been exhaustively discussed in the chapter on industries we will not refer here to the development of any particular industry.

Industries Conference

158. We would like to mention here that the plans for the development of industries prepared by the Ministry of Industry and Supply were discussed at the recent Industries Conference of 1947 which was attended by representatives of the Central and Provincial Governments and major industries. The Conference expressed its concern over the decline in indigenous production as compared to the peak production during war. The causes of this decline were enumerated as : Restrictions on imports and difficulty of obtaining machinery and heavy equipment, shortage of constructional materials such as steel and cement, labour unrest, currency restrictions and transport bottlenecks. The Conference also discussed the development programme prepared by the Ministry. The proposals may be classified into :—

(*i*) *Immediate Plan.*—Increasing the production to full installed capacity for established industries such as cement, steel, drugs, sulphuric acid, caustic soda, superphosphates, soaps, glass, potteries, refractories, power alcohol, paper and boards, plywood, bicycles, leather goods, machine tools and other engineering industries, electrical appliances, metals and metal products.

(2) *Short Term Plan.*—Relates to establishing new capacity and increasing production during the next three years. The industries included are : arms and ammunitions, iron and steel non-ferrous metals, industrial machinery, automobile and tractors, aircraft, ship-building, prime movers, radio receivers, telephone equipment electrical machinery and equipment, cement, heavy chemicals and electro chemicals, fine chemicals, and drugs, soap, paints, varnishes, synthetic moulding powders, glass, paper and newsprint, rubber, refractories, ceramics, sugar and power alcohol, leather and leather goods, cotton textiles, woollen goods, hosiery, rayon, silk, coir products and synthetic petroleum products.

(3) *Long Term Plan.*—It was suggested that a suitable machinery be created to undertake planning work with a view to achieving maximum self sufficiency, fuller utilisation of the resources of the country and ensuring a higher standard of living for its nationals.

The Conference adopted a number of resolutions recommending to the Government various measures, which in their opinion would meet the exigencies of the situation. A few recommendations are :—

(*a*) fullest utilisation of the existing transport facilities particularly for the movement of coal,
(*b*) special assistance to be given for increased production of various industrial products—both raw materials and finished products,
(*c*) increase in training facilities for scientists and technicians,
(*d* execution of the plans drawn up,
(*e*) establishment of a Cottage Industries Board and a full time Planning Commission.

Industrial Policy of the Government

159. Keeping in view the recommendations of the Conference, the Government moved a resolution in the Dominion Parliament defining its industrial policy. The resolution lays emphasis on increased production leading to an increase of national wealth. To achieve this end the Government feels that it could contribute more quickly by expanding its present activities and concentrating on new production in other fields rather than by acquiring and running existing units of production. But the inherent right of the State to acquire any existing concern will remain.

The resolution divides industries into three spheres, namely, those that are exclusively State monopolies, those over which the State will exercise control, and those that will be left to private enterprise to develop. Under the first category are included manufacture of arms and ammunitions, production and control of atomic energy and railway transport. These will be the exclusive monopolies of the Central Government. In case of coal, iron and steel, aircraft manufacture, shipbuilding, manufacture of telephones, telegraph and wireless apparatus (excluding radio receiving sets) and mineral oils, the State (Central, Provincial and State Government and other Public authority) will be exclusively responsible for establishing new undertakings, the existing undertakings being allowed to develop for a period of 10 years during which they will be allowed all facilities for efficient working, and expansion. At the end of 10 years, the position will be reviewed.

Under the second categories are industries, the planning and regulation of which the Central Government. is necessary in national interest. These are—salt, automobile and tractors, prime movers, electric, engineering and other heavy machinery, machine tools, heavy chemicals, fertilizers and drugs, electro-chemical industries, non-ferrous metals, rubber manufacture, power and industrial alcohol, cotton and woollen textiles, cement, sugar, paper and newsprint, air and sea transport, minerals and industries related to Defence.

The remaining industries have been left to private enterprise.

The Government has accepted the recommendations of the Industries Conference in respect of establishing a National Planning Committee and a Cottage Industries Board.

In respect of participation of foreign capital, it has been stated that such participation will be regulated in national interests, and as a rule the major interests in ownership and effective control should always be in Indian hands.

160. A plant for the establishment of a Fertilizer factory at Sindri with a capacity to produce 350,000 tons of Ammonium Sulphate per year is about to be set up. The major portion of the machinery has already been imported and is under erection at present. The factory power house will use super-heated steam at a fairly high temperature to drive the turbine generator and the exhaust steam will be used for various processing purposes. The power house will also supply electrical energy to the proposed Bihar grid besides meeting the factory's requirements.

161. A comprehensive scheme for the development of Government Test House has been submitted by the Department. It envisages strengthening of the present sanction and opening new sub-sections dealing with analysis of plastics, rubber, paper products, micro-analytical methods, as analysis, spectro graphic and spectrophotometric methods, biological and bio-chemical analysis, hydraulic test, etc.

Staff requirements

162 The Supplies Wing of D. G. I. & S. and the Dte. General of Disposals do not anticipate abnormal staff requirements. In case of other departments we give below the requirements of staff as have been estimated by the departments concerned. This includes the staff that may be needed for replacement on account of wastage and retirement.

In classifying the staff requirements we have taken into account the nature of work and the academic qualifications and practical experiences of the personnel needed. This has been necessary as all the departments have not classified their requirements into various categories.

Inspection Wing of D. G. I & S. (Ministry of I. & S.)	Officers	N. G. O.
Chemists	11	..
Civil Engineers	17	..
Mechanical Engineers	21	..
Electrical Engineers	22	..
Chemical Engineers	16	..
Metallurgists	15	
Textile Technologists	4	..
Indian Central Cotton Committee		
Physicists	2	
Chemists	4	8
Textile Technologists	2	4
Mechanical Engineers		4

Textile Commissioner—

No information has been given.

Development Wing of D. G. I. & S. (Ministry of Industry and Supply)

The demand for staff will depend on the rate of industrial development. Assuming a favourable course of developments, we may, assess the overall requirements as :—

	Officers	N. G. O.
Engineers Mechanical	15	..
Engineers Electrical	15	..
Chemists General	30	..

Iron and Steel Controller—

No intake anticipated.

Coal Commissioner Organisation—

Mining Engineers	10	..

Sindri Fertilisers Project—

Mechanical Engineers	25	74
Chemical Engineers	17	..
Electrical Engineers	19	..
Medical Graduates	5	..
Chemists Inorganic	7	..
General Chemists	60	50

Patent Office—

Engineers	10	..
Chemists	10	..
Physicists	10	..
Chemical Technologists	2	..
Metallurgists	2	..

Government Test House—

Chemists Organic	15	..
Chemists Physical	10	..
Chemists General	15	..
Chemists Analytical	10	..
Physicists	17	..
Engineers Civil	5	..
Engineers Mechanical	10	..
Engineers Electrical	4	..

Mathematical Instrument Office.—In case the recommendations for the expansion are accepted by the Government, staff requirements may be estimated as :—

Engineers Mechanical	20	100
Engineers Electrical	4	12
Physicists	8	8
Chemists	4	..
Metallurgists	4	..

(Based on 4 fold increase of the departments' present activity).

Indian Standards Institution—

Mechanical Engineers	3	..
Chemical Engineer	1	..
Chemist General	1	..
Agricultural Sciences	1	..

Departments of Industries, Delhi and Patiala, Jaipur.

Chemists	..	1

West Bengal—

Mechanical Engineers	30	15
Electrical Engineers	5	1
Chemists	10	24
Sericulturists	6	58
Biological Sciences	1	46
Textile Technologists	12	7
Physicists	2	237
Leather Technologists	2	24
Statisticians	2	13

	Officers	N. G. O.
Orissa—		
Civil Engineers	4	7
Mechanical Engineers	4	71
Chemists	3	3
Sericulturists	2	7
Estuarine Biologists	3	4
Mathematicians	1	1
C. P. & Berar —		
Engineers	7	18
Chemists	12	20
Statistician	1	..
Geologist	1	..
Palaeontologists	2	..
Bombay—		
Engineers	11	5
Chemists	10	..
Geologists	2	..
Statisticians	8	25
Madras, Mysore and Travancore—		
Mechanical Engineers	54	61
Electrical Engineers	9	15
Civil Engineers	21	30
Automobile Engineers	7	..
Chemical Engineers	5	12
Radio Engineers	4	11
Sound Engineers	1	1
Unclassified Engineers	20	..
Marine Engineers	3	..
Technologists		
Food	3	8
Printing	3	4
Fisheries and Navigation	37	12
Textile	2	5
Leather	5	1
Silk	5	..
Ceramic	5	..
Glass	1	..
Metallurgists	1	..
Paper	4	..
Coil Manufacturers	2	..
Analytical Chemists	5	..
Biochemists	27	..
Textile Chemists	1	..
Industrial Chemists	41	..
Soap, oils and Fats Technologists	26	..
Chemists Organic	2	..
Applied biologists	19	..
Drug Research Laboratory (Jammu)—		
Organic Chemists	30	..

The staff requirements may be summarised as :—

		Officers	N. G. O.
Chemists—			
General and Applied	Post Graduates	275	50 (Graduates in Science)
Inorganic		7	..
Organic		47	..
Physical		10	
Analytical		15	..
Biochemists		27	..
Physicists		288	..
Palaeobotanist		2	..
Biological sciences		75	..
Sericulturists		73	..
Statisticians		51	..
Chemical Technologists	Graduates	108	..
Leather Technologists	Graduates	42	..
Geologists	Post-graduates	3	..
Agricultural Sciences	Graduates	1	..
Textile Technologists		41	..
Medical Personnel		5	..
Metallurgists		22	..
Engineers—			
Civil	Graduates	85	..
Mechanical		359	..
Electrical		132	..
Chemical		51	..
Minings		10	
Automobile		7	..
Marine		3	..
Diploma Holders Elect./Mechanical		..	232
		1,789	..
	Grand Total	2,021	..

Pattern of employment and training facilities

163. In the previous paragraph we have indicated the numbers and types of personnel that would be needed for the various development projects that we have considered under this group of departments. By far the largest requirements are in the field of engineers, chemists and physicists. This personnel would be required most for the purpose of inspection, supervision, production and analytical testing. Excepting about hundred persons, who, we estimated will be employed in junior capacities at the Fe tilizer Factory at Sindri, the rest of the personnel must hold a Degree in Engineering and or a post-graudate scientific degree with suitable experience in the relevant subject.

164. The training facilities available at the laboratories of the Directorate of Industries are of very routine nature. Generally speaking, the laboratories are not properly equipped and are understaffed. The facilities available with the Controller of Printing and Stationery and at the India Security Press are of very specialised type and would be of interest only to those two departments.

165. The Government Test House can make arrangements for the training of a few physicists, chemists and engineers in the analytical testing technique and that too after additional equipments have been received and development projects aken in hand.

166. The Inspection Wing of the D. G. I. & S. offers training facilities for standardisation technique for various manufactures handled by this department. We are of the opinion that for a proper scientific development of the industrial product on, standardisation of manufacture is extremely desirable and necessary. The Inspection Wing can certainly help to some extent in making arrangements for the training in standardisation technique for the technical staff of factories and other Government departments. The Indian Standard Institute is still in the early formative stages and when it starts functioning it will be in a position to supplement these training facilities fully.

167. As a result of our survey we are of the opinion that arrangements may be made for the training of the following categories of personnel annually at the Institute indicated.

Sindri Fertilizer Factory	100 Apprentices
Mathematical Instrument Office	10 Mech. Engineers.
Coal Commissioner Organisation	2 Mining Engineers.
Government Test House	5 Chemists.
	5 Physicists.
	5 Engineers Elec.
Inspection Wing	15 Engineers
	5 Textile Technologists.

Training Abroad

168. *Training Abroad* We give below the number of persons and subjects for which the departments concerned consider it necessary to send their staff for training abroad in the next 5 years.

Name of Organisation	No. of persons (5 years)	Remarks
Sindri Fertilisers Project	16	Senior posts may have to be filled in by foreign persons, experts who have had experience in production engineering, maintenance engineering, etc.
	18	Persons recruited in India will have to be trained abroad in chemical engineering, production engineering and gas synthesis.
The Indian Standard Institute	3	May be sent abroad for standardisation technique.
Coal Commissioner	10	For training in coal washing methods, mining machinery wires and ropes, manufacture of explosives for civilian purposes.
Government Test House	No. not stated.	It is felt that staff is to be trained abroad in X-ray testing spectrographic methods of analysis, oil technology, high voltage technique and modern methods of analysis, etc.
Development Wing of D. G. I. & S.— Ministry of Industry and Supply	4	To be trained in specialised branches of mechanical engineering such as manufacture of automobiles, power plants, shipbuilding, aeronautical engineering, air conditioning, ferrous and non-ferrous alloys.
	2	For training in foundry practices, manufacture and inspection of machine tools, heat treatment of alloys etc.
	2	Manufacture of electrical and generators, cables and wires radio and telephone equipment.
	2	On deputation to learn the latest technique in metallurgical operations.
	10	
Inspection Wing	16	To be sent for manufacture of testing machines, tools, boilers, locomotives, internal combustion engines jigs and tools, welding and production engineering.
The Indian Central Cotton Committee	5	For training in X-ray studies on textile fibres, hosiery. electron microscopy, ginning and designing textile machinery.
Department of Industries Jaipur	13	Training in mechanical and electrical engineering, chemical engineering, industrial statistics, leather technology, agricultural and animal husbandry.
Drug Research Laboratory, Jummu	6	Synthetic drugs and anti-biotics.
Department of Industries, West Bengal	19	In cinematography, manufacturing of chemical plant, fuel, technology glass technology, ore dressing, paints, varnishes, lacquers, rubber technology wood technology, explosives coal, tar distillation, paper technology production of alkalies, hydrogenation of coal, food technology, plastics, high polymers and rayon.
Orissa	6	Mechanical engineering, power plant, locomotives, automobile, aeronautics, armaments, railways.
	1	Municipal and sanitary engineering.
	3	Electrical engineering.
Bombay	5	For automobile engineering, machine tool manufacture rayon and plastics and electrical machinery.

(For the entire industrial development of the Presidency, the Post-war Development plans estimated the number of persons to be trained abroad as 155 for the first three years).

Total	131	

169. The following departments, however, do not consider it necessary to depute their staff for training abroad :—

The Patent Office, Iron & Steel Controller, Disposals Directorate, Mathematical Instrument Office, certain sections of the Development Directorate of the Ministry of Industries and Supplies, Director of Industries, Delhi, Patiala, Mayur Bhunj.

Requirements for training abroad in respect of some of the organisations under the Director of Industries, Madras and Mysore have already been considered under the Chapter on Industries.

170. The India Security Press contemplates expansion of their plant and installation of additional machines such as Rotary Lithographic Off-set presses and embossing machines for postcards, envelopes, etc. Installation of a printing machine for the photogravure method is in progress. It is also expected that a power house and general stores will be constructed in the premises.

Ministry of Labour

171. Since the resettlement of ex-servicemen and their training in various vocations has been considered as an essential pre-requisite for the fulfilment of post-war development and expansion programmes we state here the aims and objects of the Directorate General of Resettlement and Employment under the Ministry of Labour. This Department was set up immediately after the war for resettling ex-servicemen and providing training to those ex-servicemen who needed it Employment exchanges were also simultaneously set up to register persons seeking employments and put them in touch with employers. Fresh registrations are classified into various trades and crafts numbering 155. Since the partition of the country the facilities available at the employment exchanges have been thrown open to all.

172. This department has organised four types of training institutions. The two types deal with technical training schemes and vocational training schemes. There are at present 86 technical training centres with a total accommodation of 12,127 persons and are located at suitable places all over the country and provide training in 50 engineering and building trades. As far as possible the training is co-related to employment opportunities available and the period of training is reduced to the barest minimum by starting the course of training at an appropriate stage in the syllabus, if the trainees' previous experience and qualifications justify. There are 118 vocational training centres which can be classified as :—

(1) Labour Department Training Centres.

(2) Other Institutions of the Central and Provincial Governments such as workshops, factories and farms.

(3) Private undertakings and employer's establishments.

Apprenticeship training scheme has been evolved and will provide training facilities to about 3 9,00 persons per year in various trads and occupations as shown below :—

Agriculture and allied occupations	10,000
Cottage and Small Scale industries	17,080
Commercial occupations	4,550
Miscellaneous occupations	4,870
Apprenticeship schemes (Non-Engineering)	2,500
	39,000

173. Another service department, namely, the Controller of Printing and Stationery, under the Ministry of Works, Mines and Power, meets the requirements of other Governments in the matter of stationery articles and printing. It employs technical staff for the purpose of standardisation of articles, general supervision of printing presses and drawing up specifications for certain articles which were hitherto imported and are now being made in the country.

174. The India Security Press at Nasik carries out printing of postage and fiscal stamps, bank and currency notes, match and tobacco excise labels, postal stationery and similar articles.

Inspection Wing of the Directorate General of Industries & Supplies

175. This Division is responsible for the inspection and standardisation of manufactures undertaken in the country. Investigations have also been carried out on the ' grain size control in steel ' at the Metallurgical Inspectorate, Jamshedpur. Normal duties other than inspection are advisory in nature with a view to improve methods of manufacture.

176. There are two other organisations namely, the Indian Central Cotton Committee sponsored by the Government of India in the Ministry of Agriculture and the Office of the Textile Commissioner, Bombay, Ministry of Industry and Supply who have also been responsible for standardisation in textile industry. The Indian Central Cotton Committee maintains a laboratory and conducts research of fundamental and applied nature on cotton plant and fibre, utilisation of mill waste and has also conducted a survey of cellulose bearing materials. It carries out testing and consultation work and gives advice to textile mills on all technical matters. The statistical data collected by the Textile Commissioner regarding the production of each mill, requirements for important raw materials, distribution of manufactured products have been extremely valuable in laying down the policy of controlled distribution.

The Directorate General of Disposals

177. The department has been entrusted with the disposals of materials rendered surplus on the cessation of hostilities. It is a temporary organisation and employs technical staff.

Sindri Fertilizer Project

178. As a result of the recommendations of the Food Grains Policy Committee and the War Resources Committee it was decided to establish the ammonium sulphate fertil zer industry as a state owned enterprise. The planning of this project was carried out under the Ministry of Industry and Supply and the factory is being erected at Sindri in Bihar. It would employ the gypsum process and would produce 1000 tons of ammonium sulphate per day. Ammonia would be synthesised from atmospheric nitrogen. Calcium carbonate, the bye-product, would be utilised for the manufacture of cement. This industry is a basic heavy chemical industry and in view of its importance in munition production it has been established as a state enterprise. The capital cost is estimated at Rs. 10—12 crores and the sale price of fertilizer has been estimated at Rs. 120 per ton. It will be one of the largest factories of its kind in the world. The equipment has started arriving and is being assembled.

179. A large number of separate autonomous departments under the Central Government carrying out other important activities, are under the Ministry of Industry and Supply for general administrative control. These departments are :—

(*i*) *Iron and Steel Control Organisation*

This is an administrative office and its functions are to issue quota certificates keeping in view the over-all requirements of the country and the amounts available from indigneous production and imports of iron and steel products.

(*ii*) *Coal Commissioners Organisation*

It is an advisory unit for the inspection of coal mines and coking plants and to advise on production and distribution of coal from state owned and private mines.

(*iii*) *Patent Office*

This department examines new applications for patents, trade designs, etc., and rendered advice to the Government on various points relating to patents.

(*iv*) *Government Test House*

The activities of the laboratory are mostly confined to testing and such applied research as is necessary for day to day work, for example, reasons of failure of materials in service, improved methods in testing, devising new standards and specifications for indigenous manufactures, advising government and industries on various technical matters etc. The department charges a fee for the issue of test certificate.

(*v*) *Mathematical Instrument Office*

It has a well equipped workshop for undertaking work in connection with manufacture of fine instruments, grinding of lenses, and other precision work. During the war it was taken over by the Defence Department as one of their Ordinance Factories and has recently been handed over to the Ministry of Industry and Supply. It is understood that a Committee appointed to advice on the reorganisation and development of this institute has recommended its expaension so as to render maximum help in the establishment of a fine instruments industry in the country.

(*vi*) *Indian Standards Institution*

This is an autonomous body under the administrative control of Ministry of Industry and Supply. The main functions are to formulate standard specifications for various manufactured articles. Work has been taken in hand to draft specifications for engineering manufactures and textile industries.

180. As stated earlier the Provincial Governments' departments of industries give advice on the promotion of industries in their provinces keeping in view the availablity of raw materials, technical skill etc. The functions of the various departments of industries, generally speaking, are similar and we do not propose to relate these separately. Information has been received from the departments of industries, Delhi, Jaipur, Patiala, Bihar, Orissa, West Bengal, C. P. & Berar, Bombay, Madras, Mysore and Travancore. In some provinces and states, industrial establishments have been set up under the general administrative control of the department, for instance, the Government Porcelain factory, the Central Industrial Workshop, both belonging to Mysore Government, are semi-autonomous units under the general administrative control of the industries departments. Similarly, the Kerala Soap Institute is a semi-autonomous unit for teaching and research under the Department of Industries, Madras, and the Drug Research Laboratory, Jammu, is a state-owned concern, carrying out manufacture of drugs and research in drug standardisation and allied work. Some of these establishments have been covered under the chapter on Industries, and here we will only discuss such Government sponsored departments as have not been included in any other chapter.

Directorate General of Disposals

181. The Disposal Organisation is a temporary measure and as soon as the goods have been disposed off, this organisation will be disbanded.

182. The Controller of Printing and Stationery envisages the establishment of another press to meet the increased requirements of the Government Departments but no definite decision has yet been taken on this issue.

183. The India Security Press contemplates expansion of their plant and installation of additional machines such as Rotary Lithographic Off-set presses and embossing machine for post cards, envelopes, etc. Installation of a printing machine for the photograveure method is in progress. It is also expected that a power house and general stores will be constructed in the premises.

184. The Indian Central Cotton Committee are contemplating an extension of the Laboratory buildings to accommodate the fibre and yarn testing section, hosiery research section and propose to under take research on standardisation of various yarns and suitability of processing Indian cottons for the manufacture of hosiery goods. It may also be mentioned here that the Cotton Textile Fund Committee is planning the establishment of Textile Research Institute. The staff requirements for the proposeb Institute have been covered under a different section of the report, namely under Government sponsored Research Organisations.

In order to ensure satisfactory arrangements for the supply of cotton textile items required by Defence Services during the last war the then Department of Supply transferred the cotton textiles portion of the late Indian Stores Department to Bombay under the name of Cotton Textiles Directorate. On the imposition of control on cotton textiles in June 1943 the name of the office was changed to that of the Office of the Textile Commissioner. The main functions of the office are administration of the control on cotton textiles, which includes control on the production, distribution and prices of cotton cloth and

yarn and generally to advise Government on all matters connected with cotton textiles. In addition, Textile Commissioner's office also arranges the distribution of textile millstores and dyes to textile mills. The strength of the Office consists of about 103 Gazetted Officers and about 1,600 non-gazetted staff (inclusive of Class IV).

185. The Development Programme of the Development Directorate of the Ministry in general relate to working out plans for the development and expansion of various industries like manufacture of diesel engines, ship-building, automobiles, bicycles, hurricane lamps, transformers, storage batteries, electrical lamps and other domestic electrical appliances, insulators and refractories, abrasives, beltings, ferrous and non-ferrous alloys, machine tools, etc. Since the development of these industries has been exhaustively discussed in the chapter of industries we will not refer here to the development of any particular industry.

186. A committee was appointed to advise on the re-organisation and expansion of the Mathematical Instrument office. Its report has not been made available to us. The development plans, if any, will be drawn up after this committee's report has been accepted. It is understood that increased production has been urged and the committee feel that the scope and activities should be increased considerably, at least 4 times. It may, however, be assumed that greater attention will in future be paid by this organisation towards the development of the manufacture of scientific instruments and other precision instruments.

187. Expansion of the laboratory under the Department of Industries and Labour, Delhi Province, is under consideration so as to enable the laboratory to undertake research on the utilisation of industrial raw materials and production of finished goods.

Department of Industries, Jaipur, contemplate development of textiles, ceramics and leather industries.

Development Department, Patiala, envisage development of State owned cottage industries and establishment of large scale industries, such as textiles, sugar, and power alcohol, glass, leather, bone products and cardboard industry. Establishment of a technical institute for men and women is also contemplated.

188. The Indian Standards Institute has already taken up the work of drafting specification for manufacture of engineering and textile industries. For other industries also this work will be taken up during the next five or ten years, provided the life of the institution is renewed after the expiry of the present term.

189. The development and expansion programme visualised by West Bengal Department of Industries relate to the development of medium and large scale industries such as salt industry, leather industry, sericultural development including silk weaving and marketing, setting up an organisation to purchase, inspect and sell manufacturers of indigenous industries, survey of power resources of the Province, training and resettlement of ex-service men and establishment of technical and industrial training centres.

190. Plans of the Department of Industries, Government of Orissa, also relate to the training and resettlement of ex-servicemen and the provision of facilities for industrial training in various industries such as paper, glass, soap, sugar, manufacture of machinery and development of fisheries. It is proposed to open more fish curing yards and to supply fish tackles and other implements on co-operative basis.

191. No plans have been formulated for the development of Mayurbhunj State. This State is very rich in minerals, especially iron ore, vanadium bearing magnetite containing traces of uranium, kyanite and China clay. Obviously if any development is to take place the possibilities lie in the increase in mining activities.

192. The Development Plan of the Department of Industries, Central Provinces and Berar relate to giving increased technical assistance, compilation of commercial and industrial statistics, establishment of bone meal industry, expansion of the industrial and testing laboratories, improvement in timber seasoning, textiles, silk and tanning industries and establishment of industrial training Institute.

193. The Department of Industries, Bombay, envisage an expansion of the industrial chemist's laboratory, the industrial engineers workshop, development of leather goods industry and appointment of regional industrial officers to advise on developments and improvements in various industrial fields etc.

Madras, Mysore and Travancore

194. The developments envisaged by various semi-autonomous industrial units under the Departments of Industries have been discussed elsewhere in this report. Generally speaking developments comprise improvements in engineering and technological education and development of industries like ceremic, glass, soap, oil, paper, leather, fisheries, sericulture and silk filature industries.

195. The development anticipated by the Directorate General of Resettlement and Employment relates to the establishment of a Central Institute for the training of instructors required to staff various vocational training centres. It is expected that the Central Institute will be in a position to train 200 instructors at a time. The training scheme was originally formulated to meet the short term needs of re-establishing ex-service men in useful trades in the country. In view of the manifold development programmes planned by industries and Government Departments there will be considerable need for trained skilled workmen and craftsmen. One of the foremost functions of these technical training schemes is to meet the need for skilled tradesmen.

196. The Drug Research Laboratory, Jammu, envisages an increase of 20 times in the annual output of pharmaceuticals and insecticides, and increased research activity for the utilisation of crude drugs of the State. The entire programme is held up on account of present disturbed conditions.

197. The Mathematical Instrument Office has some very unique training facilities in the manufacture of optical instruments and other precision scientific instruments. They train their own staff and are not at present in a position to undertake the training of additional men. It may be mentioned that during the war time this organisation trained and provided the trained nucleus for the Scientific Instruments Workshop at Dehra Dun under the Defence Ministry.

198. The Coal Commissioner's Organisation can train 2 mining engineers per year and they have suggested that these trained apprentices should eventually be absorbed in their organisation.

199. When the Fertilizer factory is established at Sindri and starts functioning it will be possible to provide practical training for Indian Nationals in high pressure gas synthesis, high pressure steam generating turbines, chemical engineering and production engineering. Of the two training schemes under the consideration of the Department, one relates to the training of 25 Engineering graduates for 3 years in various departments of the factory. The trained engineers if otherwise suitable, will be employed as shift engінerers/shift charge engineers. The other training scheme relates to trade apprentices, *i.e.*, matriculates who after specific training in one department may find employment in the factory as chargemen/assistant foremen. It has been suggested that in the initial stages the recruitment be restricted to 75 students equally divided amongst the power house plant, chemical plant and mechanical engineering plant. As the scheme develops and production starts, the number of trainees should be doubled. The training is to last for 3 years and will not carry any guarantee of employment.

Department of Industries/Civil Supplies/Development

It also acts as the central procuring agency for Government Departments.

002. Another service department, namely, the Controller of Printing and Stationery, under the Ministry of Works, Mines and Power, meets the requirements of other Governments in the matter of stationery articles and printing. It employs technical staff for the purpose of standardization of articles, general supervision of printing presses and drawing up specifications for certain articles which were hitherto imported and are now being made in the country.

201. The India Security Press at Nasik carries out printing of postage and fiscal stamps, bank and currency notes, match and tobacco excise labels, postal stationery and similar articles.

Directorate of Inspection

202. This division is responsible for the inspection and standardization of manufacturers undertaken in the country. Investigations have also been carried out on the " grain size control in steel " at the Metallurgical Inspectorate, Jamshedpur. Normal duties other than inspection are advisory in nature with a view to improve methods of manufacture.

203. There are two other organizations namely, the Indian Central Cotton Committee sponsored by the Government of India in the Ministry cf Agriculture and the Textile Commissioner, Bombay, Ministry of Industry and Supply, who have also been responsible for standardization in textile industry. The Indian Central Cotton Committee maintains a laboratory and conducts research on fundamental and applied nature cn cotton plant and fibre, utilization of mill wastes and has also conducted a survey of cellulose bearing materials. It carries out testing and consultation work and gives advice to textile mills on all technical matters.

Sindri Fertilizer Project

204. As a result of the recommendations of the Food Grains Policy Committee and the War Resources Committee it was decided to establish the ammonium sulphate fertiliser industry as a State-owned enterprize. The planning of this project was carried out under the Ministry of Industry and Supply and the factory is being erected at Sindri in Bihar. It would employ the gypsum process and would produce 1,000 tons of ammonium sulphate per day. Ammonia would be synthesised from atmospheric nitrogen. Calcium carbonate, the bye-product, would be utilized for the manufacture of cement. This industry is a basic heavy chemical industry and in view of its importance in munition production it has been established as a State enterprize. The capital cost is estimated at Rs.17 corres and the sale price of fertilizer has been estimated at Rs. 120 per ton. It will be one of the largest factories of its kind in the world. The project is in an advanced stage of construction.

.205 There are other subordinate organisations under the Ministry of Industry and Supply whose chief functions are set out below :—

Iron and Steel Control Organization. This is an administrative office and its functions are to issue quota certificates keeping in view the over-all requirements of the country and the amounts available from indigenous production and imports of iron and steel products.

206. The Coal Commissioner's Organization can train two mining engineers per year and they have suggested that these trained apprentices should eventually be absorbed in their organization.

207. When the Fertilizer Factory is established at Sindri and starts functioning it will be possible to provide practical training for Indian Nationals in high pressure gas synthesis, high pressure steam generating turbines, chemical engineering and production engineering. Of the two training schemes under the consideration of the Department, one relates to thetraining of 25 engineering graduates for three years in various departments of the factory. The trained engineers, if otherwise suitable, will be employed as shift engineers/shift charge engineers. The other training scheme relates to trade apprentices, *i.e.*, matriculates who after specific training in one department may find employment in the factory as chargemen/ assistant foremen. It has been suggested that in the initial stages the recruitment be restricted to 75 students, equally divided amongst the power house plant, chemical plant and mechanical engineering plant. As the scheme develops and production starts the number of trainees should be doubled. The training is to last three years and will not carry any guarantee of employment.

208. As a result of our survey we are of the opinion that arrangements may be made for the training of the following categories of personnel annually at the institutes indicated :—

Sindri Fertilizer Factory	100 apprentices.
Mathematical Instrument Office	10 Engineers, Physicists and Chemists,
Coal Commissioner' Organization	2 Mining Engineers.

209. The technical divisions under this group are :—

(*i*) The Salt and Excise Division.

(*ii*) Central Board of Revenue Laboratory and Opium Factory.

(*iii*) Government of India Mint, Bombay and Calcutta ; and the new Mint at Alipore.

Technical staff is employed in the Central Salt and Excise Division for technical-*cum*-administrative services in levying and collecting excise duties on tobacco, rectified spirits, motor fuel, drugs, etc. Analytical testing of imported articles, such as drugs and fine chemicals, is undertaken at the Chemical Laboratory at Delhi.

The Opium Factory in Ghazipur is divided into two sections—the Government Alkaloid Works, Ghazipur, and the Opium Factory itself. The former is an integral part of the Factory, but has been separated from that position of the Factory where the manufacture of excise opium is carried on, as in the Alkaloid Works, the manufacture of opium alkaloids only is carried on. The Opium Factory also carries out applied research on the recovery of alkaloids.

The India Government Mint at Bombay and Calcutta mints coins and medals for the Government and undertakes refining of gold and silver. Research is also carried out on assaying of fine metals. A new mint is under construction at Alipore and the Calcutta Mint will be merged with this new mint later on.

210. Staff employed :—

	Gazetted.	Non-Gazetted
EXCISE COLLECTORATE		
Engineers	1	4
Medical Graduates	1	1
C. B. R. LABORATORIES		
Chemists	12	29
OPIUM FACTORY, AND LABORATORY, GHAZIPUR		
Chemists	6	18
Biologist	1	..
Engineers	3	4
INDIA GOVERNMENT MINT, BOMBAY AND CALCUTTA		
Mint Masters (Engineers)	2	..
Chief Technical Adviser (Chemist)	1	..
Deputy Mint Masters (Metallurgists)	2	..
Asst. Masters (Engineers)	2	..
Chief Assayer (Cehemist and Metallurgist)	1	..
Deputy Chief Assayer (Chemist and Metallurgist)	1	..
Works Melters (Trained person)	1	..
Engineers and Melters (Trained persons)	23	..

Development Programme

211. No development is envisaged by the Central Excise Division but its activities may increase if additional articles are declared as exciseable.

As regards the Opium Factory, the whole future of this establishment is still undecided. The alkaloid plant at Ghazipur is capable of producing opium alkaloids to the extent of over 10,000 lbs. per year but the actual production is only about 620 lbs. Although the requirements of India for these alkaloids are about 1,500 the whole of this quantity is not purchased from these Works. This is partly due to the fact that the concerns in the country still possess some war-time stocks, and that a part of the requirements continue to be imported. Although India produces about 25% of world's raw opium her production of opium alkaloids has been estimated to be about 2% of the world's production. It is desirable, therefore, that India's quota of opium drugs for the world market should be

proportionate to the amount of the raw material produced in the country. It is understood that a proposal is under way to decide, *inter alia*, whether the Alkaloid Works at Ghazipur should aspire to capture the Indian market only or should aspire to export to other countries also, whether the Indian industry should in this matter receive some assistance by way of prohibition of imports of such of the opium alkaloids as are manufactured in India or can be manufactured in India and whether exports of raw opium should be allowed to countries which manufacture opium alkaloids out of the raw opium supplied by us and which compete unfairly with our products.

The main development contemplated in the India Government Mints is the construction of a new Mint at Alipore, which has been taken in hand. It is intended that the India Government Mint at Calcutta should be merged with the new Mint at Alipore after the latter has started functioning. The BombayMint has also envisaged undertaking research on the electro-refining of silver and processing of silver.

Staff requirements

212. Staff will mostly be required for replacement on account of wastage and retirement, etc, and the numbers may be estimated as :—

Chemists	7
Mechanical Engineers	6
Electrical Engineers	3
Metallurgists	3

Training facilities

213. Training facilities are only available in these Departments in analytical methods of testing drugs, fine chemicals and precious metals. A scheme can certainly be developed for the training of analytical chemists at the C. B. R. Laboratories provided the Government gives permission and arranges for necessary facilities such as additional laboratory space and equipment. About fou students may be accommodated for training at present, two at the C. B. R. Laboratory and two at the Opium Factory. The Departments have stated that at least three persons should be sent abroad on deputation to study the latest methods of analytical testing and assaying of fine metals.

DEPARTMENTS OF AGRICULTURE, FOOD, FORESTS, FISHERIES AND ANIMAL HUSBANDRY

Present Activities

214. The Ministry of Food of the Central Government is practically an administrative unit. All work connected with storage of food grains and development of processed food industries has been transferred to other Ministries. There is, however, a Technical Adviser to tender advice on various questions. Laboratory facilities for routine type of analytical testing are also available.

215. The work of the Ministry of Agriculture is carried on through its Administrative Divisions which control various departments such as the Survey of India, Zoological Survey of India, Indian Veterinary Research Institute, Indian Dairy Research Institute, Forest Research Institute and the Indian Council of Agricultural Research and a number of Institutions for Agricultural Education and Research. The Ministry has also taken over the work relating to sugar and vanaspati industries and "Inspections" are hitherto done by the Ministry of Food The workr in connection with the agriclutural and food statistics is done in Food Ministry and the D. G. C. I. &. S. of the Commerce Ministry has also been entrusted to Agriculture Ministry. The work on palm gur development has also been recently started. A number of Advisers have also been appointed to advise the Government on agricultural development, fruit development, improvement of dairy sciences and problems connected with irrigation, cattle utilisation, fisheries, animal husbandry, plant protection, locust control, agricultural machinery, refrigeration, tractors and forests, products,crop planning, crop and cattle insurance, palm gur development and soil conservation work.

The Survey of India

216. The department carries out topographical surveys, collects data on geodetic and geophysical problems and conducts research on the figure of earth, levelling and var ation of latitude and longitude, and advises other Government Departments on air survey, testing of survey instruments, etc.

Botanical Survey of India

217. The department maintains an industrial section in the Indian Museum, Calcutta, and conducts fundamental research on systematic botany at the Royal Botanic Gardens, Calcutta. Applied research is undertaken on the econcmic and industrial use of plants such as those yielding fibres, dyes, resins, essential oils, starch and algae. Crude drugs are also identified and the department advises in respect of industrial utilization of vegetable resources of the country. The Botanical Gardens contains a good collection of foreign and Indian plants.

Zoological Survey of India, Calcutta

218. The department carries out systematic study of zoology with special reference to anima ecology and zoo-geography. On the applied side, the department only tenders advice in respect of identification of specimens, carries out faunistic surveys in connection with fisheries development and construction of dams and weirs, spread of animal-borne diseases, and also undertakes publication of zoological work on Indian fauna in this country and abroad.

Indian Council of Agricultural Research

219. The Indian Council of Agricultural Research undertakes, aids, promotes and co-ordinates agricultural and animal husbandry education, research and its applications in practice, development and marketing in India by all means calculated to increase scientific knowledge of the subjects and secures its adoption in every day practice. It also acts as a clearing house of information not only in regard to reserach but also in regard to agricultural and veterinary matters generally. On the basis of statistical results, experiments on crops and animal husbandry are planned and conducted through the various research schemes. The Council gives advice to Provinces and States on agricultural and animal husbandry problems and administers research schemes financed by it at various research institutes and stations.

The research and teaching institutes under the Ministry of Agriculture or under their constituent body, *viz.*, I. C. A. R. may be enumerated as :—

Indian Agricultural Research Institute, Delhi (under the Ministry of Agriculture).	Mainly for research and post-graduate training of students in various subjects relating to agriculture. Facilities for fundamental and appliei research are available.
Sugar cane Research Institute, Coimbatore (under the Ministry of Agriculture).	These are primarily research institutes for work on specialised lines but also undertake training and research for post-graduate students.
The Central Tobacco Research Institute, Rajamundri (under the Ministry of Agriculture).	
Central Horticultural Research Institute (under the Ministry of Agriculture).	
Rice Research Station, Cuttack (under the Ministry of Agriculture)	
Indian Institute of Fruit Technology (under the I. C. A. R.)	
Central Potato Research Institute (under the Ministry of Agriculture)	

Since the activities of these institutes have been considered in detail in the chapter on Agricultural Education and Research, we will not refer here to their scope and functions.

Other departments under the Ministry of Agriculture are :—

Central College of Agriculture, Delhi

220. The Ministry of Agriculture has established a Central College of Agriculture to provide training up to degree course in various agricultural sciences. The first and second year classes in this institute have been started but no research facilities are available at present.

Indian Veterinary Research Institute

221. It is a combined teaching and research institute for training of students in animal genetics, nutrition, parasitology, pathology and animal diseases. The institute also undertakes testing and manufacture of biological products and conducts basic and applied research on various aspects of veterinary sciences. The Institute is taking much interest in the popularisation of artificial insemination and the development and evaluation of more production breeds of livestock.

Forest Research Institute and College

222. It is a combined teaching and research institute and provides teaching in various subjects relating to forest sciences, such as forest botany, pathology, forest statistics, biochemistry and surveying. The institute is also interested in fundamental and applied research, specially on systematic botany, mycology, entomology, wood technology, utilisation of minor forest products, wood preservatives, composite woods, wood working, seasoning and timber mechanics, cellulose and paper.

Department of Fisheries

223. The functions of the department are to co-ordinate research in fisheries and to render such advice as will further the development of fisheries in India. Research facilities are available at the Central Marine and Inland Fisheries Research Stations, provincial fisheries laboratories and the laboratories of the Zoological Survey of India. These fisheries research stations have been started very recently and are functioning at distant places, for instance, the Central Station is at Madras Mandapam, the Inland Fisheries Station is at Calcutta Putta and the Deep Sea Fishing Station is at Bombay.

The Marine and Inland Stations carry out research on Marine Biology and Oceanography with particular reference to sharks and rays, mackerals, sardines, prawns and crabs, inland and estuarine fishes, etc. The Deep Sea Fishing Station carries out investigations regarding the charting of fishing grounds and the suitability of different kinds of net and gear in Indian Waters etc. The Marine and Inland Stations also train students in development work in regard to fisheries for Provinces and States.

Central Ground Water Organization

224. The functions of the Organisation are—

(1) Exploration of ground water potential of various areas and river basins,

(2) demonstration of the advantages of using power driven tubewell drilling equipment for intensive exploration of ground water resources of the country,

(3) training Indian personnel in the use of power driven mechanical equipment,

(4) research in ground water hydrology including co-ordination of date on hydrological, geological and meteorological observations, determination of porosity and permeability of boils and rocks, preparation of ground water inventories of selected river basins, developmnt of geo-physical methods of prospecting for ground water and dissemination of knowledge of ground water data and other information, and

(5) to help the Provinces, Unions of States and State in expediting their construction programme where so desired.

Indian Dairy Research Institute, Bangalore

225. The activities of the Institute may be divided into three branches *viz.*, (*i*) Dairy Research, (*ii*) Dairy Education, and (*iii*) Advisory work. The Institute has three main technical sections at present *viz.*, (*i*) Dairy Husbandry, (*ii*) Dairy Chemistry, and (*iii*) Dairy Bacteriology. Some work on Dairy Technology is also being done but there is no properly equipped and staffed section for this purpose.

Dairy Research

(*a*) Dairy Husbandry section is engaged in investigation on the breeding of dairy cattle for high milk production including problems of management, feeding and milk section, production and conservation of fodder crops, methods of producing clean milk, etc.

(*b*) Dairy Chemistry section deals with problems such as analysis of milk and milk products detection of adulteration of milk and ghee, refining of high acid ghee, keeping quality of butter, etc.

(*c*) The main problems in Dairy Bacteriology Section include studies on the sources of contamination in the production and handling of milk, bacteriological studies on market milk supplies, platform methods for checking unhygienic quality of milk, isolation and propagation of *dahi* cultures, etc.

(*d*) The Institute is also carrying out investigation on the technological aspects of the dairy industry including market milk, milk products, designing and construction of dairy appliances and utensils, costing etc.

Dairy Education

The Institute is running two types of courses (*i*) Indian Dairy Diploma for Specialisation in Indian dairying for two years and (*ii*) short period classes in practical dairying work for three months. Students for all parts of India are given training at the Institute.

Experimental Cattle Breeding Farm, Jubbulpore

226. The farm is in the process of establishment and its activities relate to care and management of livestock, their feeding in relation to work and production, genetical experiments with a view to stock improvement, fodder production and its preservation.

Directorate of Marketing and Inspection

227. The department advises on marketing of agricultural produce in co-operation with provinces and states. A fully equipped chemical laboratory is available for normal departmental requirements.

228. The advisory sections of the Ministry of Agriculture may be enumerated as :

Fruit Development Section

Its functions are to co-ordinate and advise on the development of horticulture, fruit and vegetables and on the improvement of fruit preservation industry in the provinces and states.

Fruit Products Control Order Section

This section carries testing of various fruit products manufactured in the country at their laboratories in order to see that quality standards are maintained. Advise is also given to industries on ways and means of improving the products.

Cattle Utilization Advisor's Office

The main activity of this section may be summarised as organising the 3,000 existing gaushallas and pinjrapoles into cattle breeding and milk producing centres, salvage of dry cattle from cities and towns and establishment of cattle concentration camps for old and unproductive cattle in interior forest areas and waste lands, and, advising Government on all problems relating to the development of cattle wealth in the country.

Directorate of Plant Protection Quarantine and Storage

This is an advisory organization and the work is carried out in co-operation with provincial departments of agriculture in respect of the control of serious pests and diseases of crops and in preventing their spread. Training facilities for junior employees are available in the department

Directorate of Storage

The activities of the Storage Division of the Directorate relate to conducting applied research on problem of storage of food grains, testing the efficiency of various insecticides and fungicides on a laboratory scale and making suitable recommendations to the provinces and states on the best methods of storing food grains. Laboratory facilities for testing are available.

Provincial Departments of Agriculture

229. The functions of the provincial departments of agriculture relate to giving technical advice, disseminating new knowledge in agricultural practices, distributing seeds, artificial fertilizers, manure, seed cakes, horticultural grafts for orchard purposes, arranging fungicidal and insecticidal spraying and dustings on pests and diseases in affected areas, tractor management, mechanised farming, animal husbandry in relation to agriculture, etc. Since these functions are more or less common to all the departments of agriculture in provinces and states, we will not describe the functions in respect of each province. It may, however, be pointed out that in different areas the economics of cultivation and type of crops raised are usually different. For instance wheat is the major crop in Northern India whereas rice is the major crop in Eastern, Southern and Western areas. The departments are also aware of the difficulties resulting from small holdings of cultivable lands, in some cases so small as to be uneconomical, and impoverishment of soils after years of tilling without addition of adequate manures. Lately newer methods of crop rotation have been introduced but so far its effect is not noticeable. There are still large tracts of waste land which may be brought under the plough when irrigation water from the new dam constructions is available. The newer discoveries in plant genetics, however, cannot be applied soon. The propagation of promising varieties is a far more difficult problem as compared to the equitable distribution. Centralised research activities do not permit taking into account the environmental conditions for all areas of the provinces and for this reason the provincial departments of agriculture have endeavoured to start regional research laboratories but so far these are few and far apart. For instances, the Government of U. P. have established a sugarcane research department, a plant protection and entomological research department, fisheries department and a Government Research Farm for work relating to wheat, barley, paddy and potato crops. Similarly the provincial colleges of agriculture also carry out applied research on various local problems relating to crop yields, improvement of soil, etc. The facilities for research and the activities of these research institutes have been considered in detail under chapter on Agricultural Education and Research and here we will only make a passing reference to the scope of their activities. These may be enumerated as aiming at better crops, bettering nutritional conditions of soil, improving upon known methods of disease control and also experimenting on nutritional requirements of cattle in the animal husbandry sections.

230. Amongs the recent developments in agro industries mention may be made of increased output of cinchona bark alkaloids, production of malt, shark liver oil, yeast from molasses, ergot from rye, processing of fruit and technology of dehydration of vegetable and fruit. Some of these development took place as a result of war and the manifold shortages caused thereby. The shark liver oil industry has prospered very well in the South.

Staff employed

231. Scientific and technical staff employed by the various organizations is as follows :—

Department	Staff employed	Gazetted	N. G. O.
Ministry of Food	Biochemists	4	..
Survey of India	Topographical Surveyors (Civil)	130	127
	Ditto (Military)	24	..
	Geophysicists	7	16
Botanical Survey of India	Botanists	4	5
Zoological Survey of India	Zoologists	7	20
	Entomologists	..	3
Indian Council of Agricultural Research	Statisticians	10	30
	Agricultural Science graduates	9	13
Indian Agricultural Research Institute	Agricultural Chemists Plant Breeders, Plant Physiologists and Pathologists, Soil Micro-Biologists, Botanists, Agricultural Engineers.	44	27
Rice Research Institute, Cuttack	Agricultural Chemist, Geneticist, Plant Breeder, Plant Physiologist, Plant Pathologist, Entomologist, Agronomist, Biochemist.	14	40

Department	Staff employed	Gazetted	N. G. O.
Central Horticultural Research Institute	Some staff has been appointed but details not known.	..	..
Indian Institute of Fruit Technology	Biochemists	1	1
	Fruit Preservation Experts	5	9
	Microbiologists	1	1
Central Potato Research Institute (Bihar)	Agricultural and Pure Science Graduates	2	3
Central College of Agriculture, Delhi	Physicists & Mathematicians	1	2
	Chemists	1	3
	Botanists	1	3
	Zoologists & Entomologists	1	3
	Agricultural Scientists	1	6
	Agricultural Engineers	1	1
	Animal Husbandry & Dairying	1	..
	Veterinary Scientists	1	..
Indian Veterinary Research Institute Izatnagar	Physicists	..	1
	Statisticians	..	1
	Zoologists	8	8
	Agricultural Sciences	2	2
	Animal husbandry	22	32
	Veterinary Sciences	15	15
	Pottery Experts	6	6
	Engineers	2	1
Forest Research Institute, Dehra Dun. (Forest Branch, Wood working branch, Botany branch, Forest entomology, Forest College).	Chemists	4	2
	Statisticians	1	8
	Biological Sciences	14	5
	Entomologists	4	3
	Lecturers & Instructors in forest sciences	16	..
	Ecologist	1	..
	Minor Forest Products Officers	2	..
	Wood Technologst	1	..
	Paper Technologist	2	..
	Unclassified subordinate Technical personnel	..	256
Department of Fisheries	Biochemists	2	..
	Botanists	2	..
	Zoologists	2	..
	Marine Engineers	2	..
	Marine biologists	8	..
	Fisheries Experts	5	..
	Statisticians	1	..
Central Marine Fisheries Research Station, Mandapam	Biochemists	1	1
	Statisticians	1	..
	Biological Sciences	4	3
	Marine Biologists	10	7
	Fisheries Experts	1	13
Central Inland Fisheries Research Station, Calcutta	Chemists	1	2
	Biological Science	8	8
	Engineer	1	1
	Statisticians	..	1
Deep Sea Fishing Station	Marine Engineers	2	3
Fruit Development Section	Agricultural Sciences	4	2
Fruit Products Control Section	Chemists (Organic)	4	3
	Agricultural Sciences	4	..
Central Ground Water Organization	Engineers—Civil	6	..
	Engineers—Mechanical &	15	18
	Engineers—Automobile	..	3
	Engineers—Electrical	1	..
	Geologists	6	..
Indian Dairy Research Institute	Head of the Institute	1	..
	Dairy Technology	3	..
	Dairy Chemistry	4	2
	Dairy Bacteriology	3	4
	Dairy Husbandry	3	..
	Dairy Biochemist	2	..
	Dairy Engineer	2	..
	Technical Assistant	..	9
	Research Assistant	..	2
	Veterinary Inspector	..	1
	Supervisor	..	5
	Overseer	..	1
	Laboratory Asstt.	..	2
	Milk Tester	..	1

Department	Staff employed	Gazetted	N. G. O
Experimental Cattle Breeding Farm, Jubbulpore	Animal Husbandary	4	3
	Agricultural Science	1	3
Cattle Utilization Advisers' Office	Animal Husbandry Dairy Sciences	3	1
Directorate of Plant Protection, Quarantine & Storage	Biological Sciences	14	17
Directorate of Storage	Entomologists	5	..
Central Agricultural Marketing Department	Agricultural Sciences	54	..
	Chemists	2	83
Directorate of Economics and Statistics	Economic and Statistical Adviser	1	..
	Deputy Economic and Statistical Advisers	2	..
	Assistant Economic and Statistical Advisers	3	..
	Research Officers	9	..
	Statistical Supdt.	1	..
	Research Investigators	..	13
	Statistical Assistant in-charge	..	1
	Statistical Assistants	..	25
	Draftsman	..	3
	Librarian	..	1
	Statistical clerk	..	1
	Computors	..	1
	Calculating machine operator	..	1
Department of Agriculture, East Punjab	Zoologists	2	13
	Agricultural Sciences	28	165
	Medical Personnel	1	..
	Engineers	1	2
Department of Agriculture, U. P.	Technical personnel employed at the Govt. Research Farm, Fisheries Deptt., Sugar Cane Research Deptt., Entomology & Plant Protection, Manure making.	30	122
Department of Forests, U. P.	Forestry	180	311
Agricultural & Veterinary Department, Jaipur	Agricultural Sciences	7	15
	Veterinary Science	1	14
Agriculture Department, Sirmoor	Agricultural Sciences	1	..
	Veterinary Sciences	1	..
	Sericulture Sciences	1	..
Veterinary Department, C. P. and Berar	Agriculture & Animal Husbandary Sciences	19	297
	Fisheries experts	3	5
Agriculture Department, Bombay	Agriculture & Animal Husbandry	34	211
Veterinary Department, Bombay	Ditto	44	322
Central Distillery, Nasik	Chemists (Organic)	3	..
	Engineers	4	..
	Medical Sciences	3	..
Fisheries Department, Bombay.	Biochemists & Zoologists	5	7
Forest Department, Bombay	Forest Engineering	7	17
Agriculture Department, C. P.	Chemists	4	..
	Botanists	8	..
	Zoologists	1	..
	Agricultural Science, Animal Husbandry & Veterinary.	44	224
	Agricultural Engineers	1	1

Department	Staff employed	Gazetted	N. G. O.
Department of Agriculture, West Bengal	Agricultural Sciences	41	97
	Agricultural Engineer	1	..
	Agricultural Chemists	1	..
	Botanists	1	..
	Forest Sciences	51	134
	Horticulture	6	6
	Veterinary Science	15	26
Department of Agriculture, Orissa	Agricultural Sciences	27	13
	Botany	5	..
	Chemists (Agriculture)	2	..
	Agriculture Engineers	4	17
	Veterinary & Animal Husbandry	11	54
Department of Agriculture, Bihar	Animal Husbandry	3	1
	Veterinary Science	17	54
Departments of Agriculture, Madras, Mysore, & Travancore	All branches of Agricultural Sciences	120	700
Department of Agriculture, Cochin	Agricultural Sciences	2	13
Research institutes under the Provincial Govts. viz. Agricultural College & Research Institute at Coimbatore, Bangalore & Baptala. Indian Sugar Cane Research Institute, Central Tobacco Research Institute.	All branches of Agricultural Sciences, animal husbandry & Veterinary sciences	120	160
Ministry of Agriculture	Cattle Utilisation Adviser	1	..
	Inspector General of Forests	1	..
	Agricultural Development Commissioner	1	..
	Irrigation Adviser	1	..
	Dairy Development Adviser	1	..
	Fish Development Adviser	1	..
	Fruit Dev. Adviser	1	..
	Co-operation Adviser	1	..
	Palm Gur Adviser	1	..
	Deputy Advisers —		
	Dy. Irrigation Adviser	1	..
	Dy. Fish Development Adviser	1	..
	Dy. Agri. Production Adviser (Fert)	1	..
	Dy. Agri. Production Adviser (Crops Planning).	1	..
	Dy. Agri. Production Adviser (Seeds)	1	..
	Dy. Dairy Dev. Adviser	1	..
	Dy. Cattle Utilisation Adviser	1	..
	Dy. Fruit Dev. Adviser	1	..
	Dy. Livestock Adviser	1	..
	Dy. Inspector Genl. of Forests	1	..
	Director, Agriculture Machinery	1	..
	Refrigeration Dev. Engineer	1	..
	Asstt. Fish Dev. Adviser	1	..
	Asstt. Cattle Utilisation Adviser	1	..
	Asstt. Fruit Dev. Adviser	1	..
	Asstt. Agri. Production Adviser (V&S)	1	..
	Asstt. Agri. Production Adviser (Ferts)	1	..
	Asstt. Dairy Dev. Adviser	2	..
	Asstt. Livestock Adviser	1	..
	Compost Dev. Officer	1	..
	Asstt. Director Agriculture Machinery	2	..

Department	Staff emyloyed	Gazetted	N. G. O.
Ministry of Agriculture—*contd.*	Public Relation Officer	1	..
	Asstt. Refrigeration Dev. Engineer	1	..
	Tech. Officer (Dairy Dev.)	2	..
	Asstt. Comp. Dev. Officer	1	..
	Officers on special duty (Soil Conservation)	5	..
	Officer on special duty (Crops & Cattle insurance).	1	..
	Technical Assistant to Cattle Utilisation Adviser.	..	1
	Technical Assistant to Fruit Development Adviser.	..	1
	Dairy Draughtsman	..	1
	Research Investigator	..	1

The staff employed by these departments may be classified as:—

	Gazetted	N. G. O.
Agricultural Science Personnel	173	306
Agricultural Engineering Personnel	6	17
Animal Husbandry & Veterinary Sciences Personnel	77	198
Horticulturists	6	6
Statisticians	13	40
Chemists (General)	12	91
Chemists (Organic)	9	3
Chemists (Biochemists)	16	14
Physicists	1	4
Dairy Sciences Personnel	6	11
Forest Sciences Personnel	254	462
Biological Sciences Personnel	42	34
Botanists	31	8
Zoologists	30	50
Marine Biologists	18	7
Fisheries Experts	9	18
Fruit Technologists	5	9
Poultry Experts	6	6
Medical Personnel	4	..
Geologists	6	3
Geophysicists	7	16
Topographical Surveyors	151	170
Engineers—Civil	8	21
Engineers—Mechanical & Drilling	21	2
Engineers—Electrical	1	1
Engineers—Marine	4	3
Unclassified staff of Research Institutes comprising agronomists, botanists, entomologists, plant breeders, plant physiologists, plant geneticists, parasitologists, mycologists, virologists, soil micro-biologists, Agricultural engineers, specialists for various agricultural crops such as sugar cane, tobacco, wheat, rice, etc.	178	483
Unclassified staff of provincial departments of Agriculture comprising Agricultural Science Graduates, Animal husbandry experts, plant breeders, animal geneticists, zoologists, agricultural engineers, demonstrators and fieldsmen.	324	1,783
Total	1,404	3,891

Development Programmes

Development programmes of the various departments under the Ministry of Agriculture are as follows :—

Survey of India

232. Development plans have not been finalised as yet and it is hoped that the activities relating to geodetic and geophysical prospecting will increase. The extent of help to be rendered by the department regarding air survey will increase as the preliminary work in connection with the construction of various multipurpose projects is taken in hand.

Botanical Survey of India

233. Reorgnization scheme has been submitted to the Government for the expansion of the industrial section of Indian Museum and for undertaking a thorough survey of vegetable resources of India

Zoological Survey of India

234. A scheme of reorganization prepared by Col. Sewell is under the consideration of the Government. The development relates to expansion of the department on modern lines to include the study of ecology and the characters of various habitats, particular attention being paid to field work. A training scheme for post-graduate students in zoology has been started and provision for facilities for the officers of the zoological Survey of India at the Central Marine Fisheries station is also envisaged.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH & THE INDIAN AGRICULTURAL RESEARCH INSTITUTE

235. It is proposed to provide additional facilities for post-graduate training in agricultural statistics in the I. C. A. R. In the Research Institute also, it is proposed that the existing sections bes trengthen ed and new divisions of agricultural engineering and statistics be opened, that research facilities be provided for training in soil survey, soil erosion and soil conservation, biochemical and nutritive studies on crops and fodder and increasing the number of students under training at the Institute.

CENTRAL HORTICULTURAL RESEARCH INSTITUTE, INSTITUTE OF FRUIT TECHNOLOGY AND CENTRAL POTATO RESEARCH INSTITUTE

236. These Institutes are being constructed and when fully established will provide training upto diploma course in the respective sciences, and post-graduate research facilities for applied and basic research on all aspects of horticulture and fruit technology.

237. The development programme of other departments under the Ministry of Agriculture include :—

Central College of Agriculture

The College has been started recently and it is proposed that during the next 10 years it should complete its developments and should undertake teaching as well as research on agricultural subjects.

Indian Veterinary Research Institute

A general expansion of the Institute and improvement of teaching and research facilities have been proposed so that additional 80 students may be taken up for training. It is stated that the development may be completed in three years.

FOREST RESEARCH INSTITUTE

A schemè for reorganization of the Institute has been considered by the Government and has beee generally accepted for implementation. The most important feature of the reorganisation plan relatu to extensive improvement of research and training facilities in various sections, notably wood preservation and utilization sections, soil chemistry section, cellulose and paper section. The Central Office will be reorganised and the administration will be strengthened. It has been proposed that a publicity branch and a statistical branch should be created.

The Department of Fisheries

The development plans of the department relate to full function'ng of the Central Fisheries Research Institute its two main and three sub-stations so that work may be undertaken on marine survey "Sen-sustricto", construction of suitable cold storage godowns, refrigerated wagons, methods of manufacturing fisheries products, utilization of fish waste, improvement of fibres used for fishing nets and line traps. Establishment of hatcheries for fresh water fish is also contemplated. The main research stations of the department will provide training facilities for a limited number of candidates. The three stations viz. the Central Marine Fisheries Research station, Mandapam ; Central Inland Fisheries Station, Calcutta ; and the Deep Sea Fishing Station, Bombay, which have started functioning on a limited scale propose to undertake survey of Indian Ocean Fisheries, fundamental and applied biological research on marine and inland fisheries and expansion of training facilities.

Indian Dairy Research Institute

The development plan of the department has been drawn up for the general development of dairies and is now under the consideration of the Ministry of Agriculture. It is proposed to establish a first-class Dairy Research Institute for training of technicians in dairy technique and allied field work and to undertake research on problems relating to dairy industry. It is also being considered whether a college for dairy science giving training upto B. Sc. and M. Sc. degree standard should be started. A scheme has also been drawn up to increase the milk production by 10% and it is likely that it will get into full swing during the next five years. The condition of dairy research in the country is far from satisfactory, and the training facil ties in dairy chemistry, bacteriology, animal husbandry, dairy technology and dairy engineering are in varying stages of development and have to be improved considerably.

238. The development programmes of other advisory sections are :—

The Central Ground Water Organization

This department has been established very recently and its research laboratory is still being organized. Its development relates to an expansion of exploratory and demonstrative work and early functioning of the laboratory on full scale. A school for the training of engineers in drilling technique has also been established by the Department.

The Experimental Cattle Breeding Farm, Jubbulpore

The farm is being established and will eventually provide facilities for research in subjects such as management of live stock, their feeding in relation to work and production, genetical experiments with a view to stock improvement, fodder product:on, etc.

The Fruit Development Section

This department proposes to apply the Quality Control Order to States which have acceded to the Indian Dominion and to improve the laboratory facilities available for testing and analytical work.

Directorate of Marketing and Inspection

" Although this Directorate is carrying out investigations on the marketing systems (prevailing in the various provinces/States) produce exchangs, development of Co-operative Marketing and reorganisation of weights and measures systems, it has continued to remain a temporary organisation from its very inception in 1935. The question of its permanency is under consideration of the Government of India."

Directorate of Plant Protection Quarantine and Storage

It is proposed to extend the facilities of this department to whole of the Indian Union and to establish well-equipped laboratories and herbarium at suitable ports and land frontiers.

No development plans have been drawn up for the office of the Director of Storage and the Cattle Utilization Adviser's Office.

239. The development plans of the provincial departments of agriculture generally speaking, relate to maximum utilization of land so as to produce sufficient food in accordance with modern nutritional standards and to produce agricultural raw materials for industries. These development schemes fall under :—

(a) improvement of organizations for an adequate supply of trained personnel, viz. Agricultural colleges and research institutes,
(b) expansion of existing research stations under the control of provinces,
(c) adopting effective land development measures for increasing the productivity of land by means of irrigation, supply of better seeds and manure, protection of crops from pests and diseases, use of better implements and better live stock, utilization of waste land or damaged land,
(d) rehabilitation of Government and private forests, reafforestation of districts devoid of forests, creation of conditions for soil conservation and adoption of steps to check soil erosion,
(e) provision for better and wider protection of livestock against diseases, nutritional disorders, expansion of veterinary services, development of vaccine sections in full-fledged research institutes,
(f) development and proper exploitation of inland esturine and coastal fisheries and establishment of research laboratories to investigate different methods of catching and processing fish,
(g) The question of mechanized farming and abolishing zamindari system is also engaging the attention of many provincial governments. Since these issues are largely a matter of policy the Government is going slow particularly with the question of the abolition of the zamindari system. It is not understood that the Central Government has acquired tractors from the Disposals Directorate and are making them available to provinces and states to mechanize agricultural development.
(h) In U. P. and South India, the Governments are also contemplating to increase their activity relating to irrigation by tube wells.
(i) The Government has also decided to undertake the manufacture of ammonium sulphate fertilizer as a State enterprise and the factory at Sindri capable of producing 1,000 tons of fertilizers per day is under construction.

Staff requirements

240. We give below estimates of additional staff requirements for the next 5 years to fulfil the developments envisaged by various departments. The numbers include staff required for annual replacement also. A few departments, however, have not classified their requirements. In view of the nature of work we have classified the total stated requirements into various categories and have indicated them as "probable distribution".

Department	Additional staff requirements	Gazetted	Non-gazetted
Survey of India	Topographical Surveyors	24	28
Botanical Survey of India	Botanists	27	..
	Chemists	4	..
Zoological Survey of India	Zoologists	51	55
	Marine biologists	2	..
	Chemist	1	..

In response to an earlier request from the Scientific Man-Power Committee, the Chief Research Officer, Fisheries Research Station (Inland), conducted a survey and has given an estimate of the requirements for zoologists for the next ten years as follows :—

	Senior	Junior	Total
Academic Zoologists	30	180	210
Entomologists	12	72	84
Helminthologists	7	42	49
Protozoologists	6	36	42
Marine Biologists	10	60	70
Fresh Water Biologists	10	60	70
Others	25	150	175
			700

(Assuming that the requirements will be eventy spread out annually, the total requirements of Zoologists for the whole of the Indian Union during the next 5 years may be taken as *350*).

Department	Additional staff requirements	Gazetted	Non-gazetted
Indian Council of Agricultural Research	Statistician	2	2
Indian Agricultural Research Institute	Agronomy	30	..
	Botany	23	..
	Chemistry	31	..
	Entomology	23	..
	Mycology	14	..
	Engineering	15	..
	Statistics	4	..
	Economics	4	..
	Directorate	6	..
Rice Research Station, Cuttack	Botanists	2	4
	Agronomists	2	4
Central Horticultural Research Institute	(Probable distribution) Agricultural Scineces.	10	12
	Horticulture	10	10
	Entomology	5	8
	Plant Pathology	3	2
Indian Institute of Fruit Technology	Biochemists	2	2
	Fruit Technologists	10	14
	Food Technologists	6	8
Central Potato Research Institute (Bihar)	Not stated	..	..
Central College of Agriculture	Chemists	1	..
	Physicists	1	..
	Mathematicians	1	..
	Botanists	1	..
	Entomologist	1	..
	Plant Pathologist	1	..
	Animal Husbandry	1	..
	Horticulture	1	..
	Agricultural Scineces	2	..
	Demonstrators	..	8
Indian Veterinary Research Institute, Izatnagar	Animal Husbandry and Veterinary Science.	26	121
Forest Research Institute, Dehra Dun	Statistics	2	..
	Soil chemists	1	2
	Ecologists	1	14
	Surveyors	..	1
	Botanists	3	2
	Mycologists	3	6
	Entomologists	1	7
	Chemists	6	13
	Engineers (Mechanical)	2	6
	Forest Products Officers	..	11
	Wood Technologists	7	25
	Paper Technologists	3	18
	Craftsmen	3	47
Department of Fisheries	Biophysics, cartography and hydrology	1	10
Central Marine Fisheries Research Stations	Chemists	2	7
	Statisticians	1	3
Central Inland Fisheries, Calcutta*	Biological Science	7	13
	Agricultural Science	1	1
Deep-sea Fishing Station*	Marine Biology	11	15
	Fisheries Experts	6	24
Fruit Development Section and Fruit Product Control Section.	Chemists	6	2
	Agricultural Sciences	2	2
Central Ground Water Organization	Engineers—Civil	1	..
	Engineers—Mechanical	21	14
	Engineers—Automobile	..	1
	Geologists	5	..
	Geo-hydrologists	2	..

*No information on likely staff requirements has been given.

Department	Additional staff requirements	Gazetted	Non-gazetted
Indian Dairy Research Institute	Biochemists	15	30
	Dairy bacteriologists	10	25
	Engineers—Dairy	10	10
	Engineers—Mechanical	2	5
	Veterinary and Animal Husbandry	4	10
NOTE.—It has been estimated that 6000 Dairy technicians will be needed in the provinces. We estimate that 10 per cent. at least will be diploma holders in dairy science.			600
Experimental Cattle Breeding Farm	Agricultural Sciences	3	3
	Animal Husbandry and Veterinary Scineces.	3	4
Directorate of Plant Protection Quarantine and Storage.	Biological Scineces	13	19
	Agricultural Sciences	14	20
Department of Agriculture, Jaipur	Agricultural Scinences	..	6
	Veterinary Sciences	..	8
East Punjab, Department of Agriculture	No information given	..	..
		(Probable distribution).	
U. P., Department of Agriculture	Agricultural Sciences	..	24
	Biochemists	..	30
	Entomologists	..	20
	Zoologists	..	5
U. P., Department of Forests	Foresters	61	150
Department of Agriculture, Sirmur	Agricultural Sciences	5	..
	Veterinary Sciences	6	..
		Probable distributio	
Department of Agriculture, C. P. & Berar	Agricultural Sciences	50	200
	Animal Husbandry and Veterinary Sciences	25	60
	Chemists	8	8
	Botanists	16	16
	Zoologists	2	5
Department of Forests, Bombay	Forest Engineers	5	6
Fisheries Department, Bombay	Biologists	4	..
	Zoologists	4	..
Veterinary Department, Bombay	Poultry Experts	..	40
	Dairy Technologists	10	30
Department of Agriculture, Bombay	Number not stated	..	..
Veterinary Department, C P. & Berar	Veterinary Sciences	51	142
Department of Agriculture, West Bengal	Agricultural Sciences	169	309
	Agricultural Engineering	4	5
	Agricultural Marketing	12	169
	Biological Sciences	56	45
	Statistics	14	47
	Soil Physicists	8	3
	Fisheries	21	81
	Forest Sciences	7	36
	Veterinary Sciences	65	95
Department of Agriculture, Orissa	Agricultural Sciences	30	61
	Chemists	10	2
	Biological Sciences	10	7
	Agricultural Engineering	..	19
	Veterinary Sciences	14	46
	Fisheries	4	18
	Forest Sciences	4	..
Department of Agriculture, Bihar	Agricultural Sciences	26	541
	Engineers-Mechanical	3	14
	Biological Sciences	7	12
	Agricultural Marketing	6	19
	Statistics	1	..
	Forest Sciences	11	20
	Fishereis	3	11
	Veterinary Sciences	64	78

Department	Additional staff requirements	Gazetted.	Non-gazetted
		(Probable distribution).	
Department of Agriculture, Madras, Mysore and Travancore.	Agricultural Sciences	700	..
	Sericultural Sciences	100	..
	Veterinary Sciences	175	..
	Agriculture Engineers	2	..
	Trained fieldmen	..	167
Department of Agriculture, Cochin.	Agricultural Sciences	1	..
	TOTAL	2,237	3,815
	GRAND TOTAL	6,052	

241. The assessment of personnel that we have so far mentioned relates only to the requirements for the normal efficient working and improvement of the departments of Agriculture and the various research institutes and agricultural farms administered by them. A large number of hydro-electric projects that have been planned will bring under cultivation a considerable area and it is anticipated that the yield of agricultural produce of the country will increase considerably. The additional land that will be brought under cultivation is given in the following table :—

Name of Unit	Name of Project	Area to be irrigated in acres.
Assam	Minor Irrigation projects under investigation about (600 Nos.)	3,00,000 (total benefited area).
Baroda States	Zankhari Project	9,000
	Sabarmati Irrigation Project	45,000
	Damodar Valley Project	7,50,000
Bengal	Gumti Dam Project	60,000
	Someswari Dam Project	1,00,000
Bihar	Kosi Valley Project	..
	Minor irrigation and drainage scheme (80 Nos. in North Bihar).	..
Bombay	Storage Gangapur Project	40,000
	Gima Storage Project	..
	Mula Storage Project	1,40,000
	Vir Dam Project	80,000
	Mahni Canal Project	3,00,000
	Tapti Canal Project	2,30,000
Cochin	Chalakudi River Division Work	23,000
	Naduthodu Irrigation Project	6,000
	Pillathodh Reservoir Scheme	3,500
Gwalior	Sind River Project	..
Jodhpur	Jawai irrigation and Hydel Project	1,10,000
Kashmir	A small irrigation project in the Anantay District.	11,000
	Hydro-Electric Project at Jagfalls	..
Orissa	The Mahanadi Valley project Machkund	25,00,000
Machkund	Hydro-electric Scheme at Dumduma Falls.	..
	51, Minor Irrigation Scheme	..
Punjab	The Bhakra Dam Project	45,00,000
	The Nangal Power Project	..

Name of Unit	Name of Project	Area to be irrigated in acres
Madras	Ramapadasagar Project	16,00,000
	Tungabhadra Project	3,00,000
	Gondikota Reservoir Project	1,00,000
	Lower Bhawani Project	2,00,000
	Various schemes for drainage in the Cauvery of Godavari and Kristna deltas under investigation.	..
Mysore	*28 Projects include—	*
	(a) Bhadra Scheme	1,80,000
	(b) Cauveri Scheme	20,000
Rajputana	The Chambal Hydro-electric Scheme	1,50,000
U. P.	The Sarda Hydro-electric Project	..
	The Nayar Dam Scheme	..
	The Rihand Hydro-electric Project	..
	The Ramaganga Dam Project	..
	The Lalitpur Reservoir	26,000
	The Naga Dam	..
	TOTAL	11·72 million acres.

Figures taken from the Journal " Engineering and Machine Tools (India) " Vol. I, No. 2 January, 1948.

242. There is no certainty as to which of these development projects will be completed during the next five years. But we can safely assume that a very large percentage will be completed during the next 10 years. None of the departments of Agriculture has been able to give any indication of the staff that will be required if this additional area is brought under cultivation. We have made tentative estimate of the personnel required on the basis of the persent acreage under cultivation, the presonnel employed at present, and the staff necessary for intensive production of the existing cultivated areas according to the latest scientific methods. We find that for 1 million acres nearly 46 persons (all categories of agricultural sciences) are required. On this basis the requirements for personnel for the new irrigation scheme are assessed as :—

Agricultural Science graduates & Diploma holders . . . 540

Considering the nature and scope of work of various categories of scientific and Technical personnel in the Departments of Agriculture and allied organisations we may classify the entire staff requirements as shown below to indicate the minimum academic qualifications of each category of personnel.

Post graduates in Science

Agronomists	36	
Biologists	193	
Botanists	94	
Plant Pathologists	6	
Mycologists	23	
Ecologists	15	
Zoologists*	122	*(Please see below)
Entomologists*	65	
Marine Biologists & Fisheries Experts	196	
Physicists	23	
Chemists	194	
Statisticians	81	
Geologists	5	

Graduates in Agriculture Engineering, Technology or prersonnel with equivalent attainments—

Civil Engineers	1
Mechanical & Drilling	38
Antomobile Engineers	1
Fruit Technologists	24
Food Technologists	14
Animal husbandry specialists	998
Forestry specialists	301
Wood Technologists	32
Paper Technologists	21
Agricultural Engineers	45
Agricultural Scientists	2611
Horticulturists	21
Topographical Surveyors	52 (Specially trained personnel)
Sericulturists	100
Poultry Experts	40
Dairy Scientists	695

Personnel with Diploma or Licentiate as the minimum qualification or with equivalent attainments—

Agricultural Scientists	507
Mechanical Engineers	32

*The Chief Research Officer, Fisheries Research Station (Inland) estimates that the requirements for Zoologists during the next 5—10 years are as follows :—

rsonnel with Post graduate qualifications.—

Academic Zoologists	210
Entomologists	84
Helminthologists	49
Protozoologists	42
Marine Biologists	70
Fresh water Biologists	70
Others	175

We accept these estimates as the probable requirments instead of the estimates asterisked above.

Training Facilities

243. The facilities available in the Survey of India relate to photolithography, geophysical prospecting and geophysical survey. The facilities on geodetic and geophysical training can be of use to other departments also but on account of the shortage of trained staff the department is not in a position to train outsiders. Other departments do not need staff trained in topographical survey and photolithography and hence the department only arranges for the training of their employees for a period of 2—3 years in the department.

The Botanical Survey of India have no facilities for training of personnel in museum work but they have facilities for training in systematic botany, economic botany and ecology in the botanical gardens and the laboratories of the department. About 6 students may be accommodated if the requisite facilities are made available. The herbarium of the department contains 4 to 5 million specimens belonging to Indian Flora. A good collection of foreign plants is also available. Facilities are also available for experimental cultivation of doubtful and unknown plants.

The Zoological Survey of India has facilities for training in systematic zoology with special reference to Indian Fauna. The training includes animal ecology, zoogeography, bianomics and other aspects of zoological sciences. We feel that at least six students may be trained in the department. Training can also be imparted in setting up zoological exhibits in museums and zoological gallaries.

Under the Central Ground Water Organization a Central Drilling School has been established to impart 3 months' preliminary instruction in the maintenance and operation of portable mechanical drilling rigs. Six months' field training is subsequently organised.

The training facilities available in the provincial departments of Agriculture is limited to training of sub-overseers, fieldmen and demonstrators in agricultural practices on various agriculture farms. Similarly, the departments of Forest provide training to personnel employed as rangers and in lower grades.

Training Abroad.

244. The training facilities available with the various agricultural colleges and agricultural research institutes have been described in detail in Chapter on Agricultural Education and Research. Here we will only indicate the number of persons who have to be trained abroad. The numbers and subjects have been suggested by the departments concerned and cover their five years' requirements.

Department	Subjects	Number
Survey of India	Photogrammetry, studies on tides, photo-lithography and map reproduction.	8
Botanical Survey of India	Museum Work	1
	Systematic botany, economic botany, ecological and survey work.	Not stated
	Vegetational survey, systematic botany and taxomony, ecology, medicinal plants, plant geography & agrostology.	30
Zoological Survey of India	Marine biology, echinodermate Taxidermy & latest methods of field and museum studies	18
Indian Council of Agriculture Research	Statistics as applied to animal genetics	2
Indian Agriculture Research Institute, Delhi	Agricultural botany, genetics and plant breeding, cytogenetics plant physiology, soil sciences and agricultural chemistry, mycology and plant pathology agronomy.	Not stated
Central Rice Station, Cuttack	Not necessary to send students abroad for the present	..
Central Horticultural Research Institute	Horticulture, agronomy, plant genetics, plant pathology and physiology, entomology	Staff already sent abroad
Indian Institute of Fruit technology	Biochemistry (preservation, canning, juices and containers), chemical engineering, refrigeration, fermentation and enzymic studies, dehydration & utilization of wastes, food microbiology.	12
Central Potato Research Institute	Potato seed certification, plant breeding and genetics and plant pathology with reference to potato viruses.	3
Central College of Agriculture	Not necessary at present, as students are already being trained in various agricultural sciences	..
Forest Research Institute Dehra Dun	Forestry	Provincial Governmen depute staff as necessary
	Plant taxomony, forest pathology & plant physiology	18
	Economic entomology, Control of forest insects, virus diseases, bological control and systematics of termites	Departmental staff has been recommended
Department of Fisheries	Biology of fishes, fishing methods and fish technology	No. not stated
Central Marine Fisheries Research Station	Inland and marine pisiculture and fisheries, oceanography Fish statistics and fishery managment.	24
Central Inland Fisheries Research Station	Fisheries Statistics, hatchery operation, fishery hydrology, aquatic manuring and fish hydro-dynamics.	5
Food Products Central Organisation	Study of sister organisations in other countries	Departmental officer may be sent, if necessary.
Central Ground Water Organization	Percussion drilling & rotary drilling	Two departmental officers will be trained.
Indian Dairy Research Institute	Dairy Chemistry, bacteriology and technology, animal nutrition, dairy husbandry and dairy engineering.	No. not stated.
Experimental Cattle breeding Farm	Animal husbandry, sheep farming, artificial insemination cooperative dairying, animal genetics.	2 officers from each of the provinces annually, including the State Unions & major states the total number is about 350 for 5 years.

Department	Subjects	Number
Directorate of Marketing & Inspection	Agricultural marketing	4 departmental officers.
Directorate of Storage	Fumigation, rodent control, grain storage.	2
Directorate of plant protection quarantine & storage	Plant Protection	Departmental staff may be sent on deputation.
East Punjab Department of Agriculture	All Agricultural Sciences	No. not stated.
U. P. Department of Agriculture	Fisheries, Soil Science and soil microbiology, plant genetics, biological control of pests, mechanised farming and agronomy, soil technology, soil minerology, insect ecology and physiology, insect genetics, bee keeping, fumigaion of crops.	61
Veterinary Department, C. P. & Berar.	Animal husbandry & allied sciences.	9
Veterinary Department, Bombay	Veterinary Science and sheep wool processing	10
Fisheries Department, Bombay	Marine biology, fishery technology, inland pisiculture etc.	4
Agriculture Department, C. P & Berar	All agricultural sciences	16
Department of Agriculture, West Bengal	Horticulture	2
	Chemical Engineering	1
	Cinchona	2
	Forestry	6
	Veterinary sciences	2
	Agricultural Sciences	70(Prepartition)
Orissa	General Agriculture	11
	Agricultural Chemistry	1
	Agricultural Botany	2
	Agricultural Engineering	1
	Agricultural Marketing	1
	Horticulture	1
	Mycology	1
	Entomology	1
	Biochemistry	1
Bihar —	Animal Husbandry—	
	Dairy Science Animal Genetics, Grass land development.	2 or 3
	Animal husbandry, Wool Technology	
	Veterinary Sciences—	
	Animal Nutrition	3
	Animal Genetics	3
	M. R. C. V. S.	20
	Helminthology	3
	Grass Research & Development	3
	Animal Physiology	3
	Animal Husbandry	6
	Pathology & Bacteriology	3
	Veterinary Entomology	3
Department of Agriculture, Madras.	Soil and plant chemistry, animal nutrition, entomology, mycology, plant breeding, horticulture, fruit preservation malt making.	28
Sugarcane Research Station, Rajamundry	Breeding, cytogenetics, taxonomy, physiology and chemistry of sugarcane.	5
Indian Veterinary Research Institute, Izatnagar	Animal Genetics, animal nutrition, poultry science parasitology, serology, immunology, pathology, bacteriology and virus study.	33
Department of Forests, Bombay	Forest Engineering	2
Department of Agriculture, Bombay	Ecology, and control of insect pests, Agricultural Engineering and economics, Agronomy, Botany, Horticulture, plant pathology	28
	Total	828

DEPARTMENT OF EDUCATION

245. The Ministry of Education in consultation with Provinces and States evolves the education policy of the country through its Central Advisory Board of Education. It is also responsible for the educational development of the Centrally Administered Areas and the Central Universities *viz.* Delhi Benares and Aligarh Universities and certain central institutions. The Provincial Governments are responsible for financing and administering the educational institutions of the provinces including the Universities. The Central Government also acts as the coordinating agency in the sphere of educational development and grants financial aid from the Central Exchequer for education and research. A number of Committees, for example the University Grants Committee, the Central Advisory Boards for Education and Archæology, Inter University Board, All India Council of Technical Education etc., have been appointed to advise the Government on specific problems.

246. The Central Government has planned and established the Delhi Polytechnic under the administrative control of the Ministry of Education. The Institute gives training in Electrical Engineering. Chemical Engineering, Textile Technology, Chemical Technology and Architecture.

The Ministry also maintain an information service on educational matters through the Bureau of Education and the Bureau of Information for Overseas Studies. The Central Secretariat Library, and the Central Advisory Board of Library are also maintained by the Ministry.

The following departments are under the administrative control of the Ministry :—

(*a*) *The Department of Archaeology.*—This Department carries out specialized work on exploration and excavation, administration of museums, expert preservation of antiques and epigraphical works and also undertakes planning and research.

(*b*) *National Archives of India.*—This Department acquires, preserves and publishes the records of National Archives and makes available their original copies to bonafide research scholars. Laboratory facilities are also available in the Department for carrying out work on paper, sizing materials, ink, recording components, examination of insecticides and questioned documents.

(*c*) *Anthropoligical Survey of India.*—The department was previously functioning under the Zoological Survey of India, but was separated from it about 2½ years ago. The activities of the department relate to conducting surveys on the origin of races, their physical characteristics the effect of man's 'habitat' with all its varying and various factors, on the evolution of tribal and racial differences, investigations of deep seated physiological characters, study of linguistics and folk-lore, primative arts, arts and crafts, etc.

(*d*) *National Library, Calcutta.*—This library is said to be one of the best in India. It does not normally employ any scientific or technical persons.

247. The Provincial Departments of Education are responsible for the administration of provincial schools and colleges. Since the activities of the individual colleges and universities have been covered under a separate section of the report *viz.* Education and Research Institutes, here we will only consider the requirements of Education Departments. Only departments of Education, Orissa, Bihar, Assam and East Punjab have replied to the questionnaire.

Staff Employed

248. Technical staff is employed in the Central and Provincial departments of Education

	Officers	N.G.O.
Engineers		
Mechanical	7	2
Electrical	7	..
Unclassified	4	..
Architects—		
Art and Drawing	19	..
Textile Technologists	5	..
Anthropolgists	19	33
TOTAL	259	127
TOTAL		386

Development plans

249. Plans have been drawn up by the Ministry of Education for the establishment of High grade technological institutions, a Central Museum of Art, Archæology and Anthropology, a Central Bureau of Psychology, a Central Braille Press, a Central Institute for Modern Languages, a Training School for Teachers, an Administrative Staff College, National Cultural Trust, Central School of Architecture and Regional Planning. Some of these schools *e.g.*, School for Modern Language, the Training School for Teachers, and experimental schools on the lines recommended by the Central Board of Education have also been started. It is possible that for various reasons all these developments may not materialis during the next five years but we believe they can be completed in the next 10 years.

250. The Planning Committee constituted to advise on the establishment of the Central National Museum has recommended that the proposed museum should comprise a Central Directorate and five departments—dealing with Art, Pre-historic Archæology, Historic Archæology, Numismatics and Epigraphy, and Cultural and Physical Anthropology. The Museum will also have a chemical Laboratory and a circulating department. The museum should be established in stages and in the first stage of development stage nucleus staff should be selected and trained for various specialised duties. In the second stage the Prehistoric Archæology division and the department of Anthropology should be added. In the third stage the remaining divisions may be added. We understand that this scheme is to be completed during the next 10 years.

251. The development plans of the Ministry also include the expansion of Delhi Polytechnic and the Indian Institute of Science, Bangalore. Plans for the expansion of the latter have been considered elsewhere in the report. The development of Delhi Polytechnic relates to expansion of the existing departments to degree standard and starting two new branches of study *viz.* mechnical and civil engineering

252. The Sarkar Committee on the development of Higher Technical Institutions in India has recommended the establishment of four Higher Technical Institutions. The recommendations have been accepted and plans have been drawn up for the establishment of Eastern and Western Higher Technical Institutes near Calcutta and Bombay. It is understood that suitable sites have been selected and arrangements are being expedited towards an early functioning of these institutions. Detailed plans for the establishment of the Eastern Higher Technical Institute have been drawn up and the institute will provide training upto the degree standard in Aeronautical Engineering, Chemical Engineering, Civil Sanitary, Electrical and Mechanical Engineering, Architecture, Metallurgy, Meteorology, Geology, Biophysics, Industrial Administration, Industrial Hygiende and Economics, Humanities, Mathematics and Statistics, Chemistry and Physics. It is also proposed that the Post Graduate department should offer research facilities in chemical engineering, chemical technology, metallurgy, civil engineering, electrical engineering, applied physics, bacteriology and biophysics, botany and geological sciences. The Western Higher Technical Institute will also be developed on similar lines. Each of these institutes willprovide facilities for post graduate study und research for about a total of 1000 students. Provision has been made in the plan for about 100 research scholars.

Education Conference 1948

253. We would like to refer here in brief to the discussion at the recent All-India Educational Conference. The most important item to be considered was the modification necessary in the C. A. B. E. report (Sargent report). It was agreed that the period required to complete the work of mass education should be considerably reduced from 40 years envisaged in the Sargent Scheme. It was also agreed that 8 years should be the period in which compulsory basic education should be introduced. It was also resolved that simultaneously a comprehensive scheme for adult education be put into operation immediately.

254. Since these decisions were taken the Ministry has introduced the scheme for compulsory basic education in the centrally administered areas. These developments together with improvements in the higher education as envisaged in the modified Sargent Scheme will obviously require the services of a large number of teachers—particularly, for science subjects. We have therefore thought it fit to estimate the requirements for science teachers on an all-India basis rather than with reference to the provincial

educational development plans which were all drawn up on the C. A. B. E. recommendation envisaging cent per cent literacy at the end of 40 years. In estimating the number of teachers it has been assumed that :—

(1) Science will not be taught in junior basic schools.

(2) That in the senior basic school elementary science will be taught as a compulsory subject with one period per day.

(3) That in the Middle Departments of the High Schools science will be taught for one period each day.

(4) That in the senior departments of High Schools science will be a optional subject and that approximately 50% of the total number of the students will study it.

255. The expansion envisaged by the National Archives of India consists of enlarging the activities of acquisition, preservation and air conditioning of record rooms. It is also likely that the laboratory facilities available in the department may be increased to some extent.

256. The development envisaged by the department of Archæology also relates to expanding their normal activities and expediting establishment of the proposed Central Museum of Art, Archæology and Anthropology.

257. The development of the Anthropological Survey of India has been drawn up with a view to carrying out a proper study of the aboriginal and tribal people and planning their eventual assimilation in the normal life of the country. At present very little systematic information is available about primitive tribes, particularly, in regard to their social habits and economic requirements. The development programme, therefore, centres round these proposals. The proposals relating to the establishment of a Bureau of Anthropology and Human Biology have been accepted in principle. The programmes of work of the Bureau will include investigations on Physical Anthropology such as somatology, craniometry and osteometry, pre-historical surveys and present day surveys ; radiological, physiological, and psychological investigation on various tribes and groups, effects of nutrition particularly mal-nutrition and study of human genetics of various tribes and groups ; cultural studies such as religious institutions, customs and habits linguistics and folk-lore of primitive tribes, their economics, technology and art, crime and tribal law, and the effect of higher civilization on their primitive life—It has also been proposed that there should be Division of publications for publishing Bulletins, Memoirs and hand books. The Bulletins and memoirs will have great scientific value, whereas the hand-books should be translated into all major Indian languages so that authentic knowledge about the aborignal tribes of India is disseminated.

The result of these scientific investigations will be of great help in devising a suitable administrative machinery for the backward and aboriginal people based on the scientific studies of their social life and traditions. The work is of a specialised nature and will have to be carried out by a staff trained in field work.

258. The development plans of the Provincial Departments of Education, generally speaking, relate to opening more elementary training schools, expansion of the existing secondary schools and training colleges, construction of buildings for schools, providing free compulsory education, improvement of education of backward communities and hill tribes, expansion of the existing colleges and establishment of provincial museums and libraries.

Staff requirements

259. Ministry of Education .—

Engineers Electrical . . . .

Engineers Mechanical . . . .

(To carry on the preliminary work in connection with the establishment of the proposed higher technical institute.)

Subject	Prof. and Lecturer	Asstt. Lecturer	Research Assistants
Mathematics and Statistics	48	56	20
Physics	32	40	20
Meteorology	16	24	20
Chemical Engineering	40	36	40
Metallurgy	20	20	20
Chemistry	24	64	40
Drawing	8	100	..
Applied Mechanics	32	60	40
Civil and Sanitary Engineering	40	60	24
Building Construction	28	68	16
Mechanical Engineering	52	92	40
Electrical Engineering	56	84	60
Aeronautical Engineering	20	28	20
Geology	32	36	20
Biological Science	28	40	20
Workshop staff	..	96	..

(The figures given are 4 times the estimated requirements for the Eastern Higher Technical Institute.)

Science Teachers

(Calculated on the assumption mentioned in para. 246. The numbers relate to all India needs.)

	India (less States)	Indian States	Total
(a) Inter-Science	1,48,610	33,786	1,82,296
(b) B. Sc.	13,212	3,008	16,220
(c) M. Sc.	4,404	1,003	5,407
TOTAL	1,66,226	37,797	2,03,923

Delhi Polytechnic

Professors	4
Assistant Professors	7
Senior Lecturers	10
Lecturers	12
Foreman	1
Draftsman	1

(May be classified as :—

	G. Officers	N.G.O.
Mechanical Engineers	7	5
Civil Engineers	7	5
Electric Engineering	2	1
Chemical Engineering	3	2
Chemical Technologists	2	1

Department of Archæology.—

Metallurgists	1
Physicists	2

Central Museum of Art; Archæology and Anthropology

Director (Archæologist)	1
Asstt. Director (Archæologist)	1
Guide Lecturers (Archæologists)	5
Archæologist	4
Anthropologists	4
Chemists	2

The National Archives of India

The staff requirements not stated. We estimate the staff for development of laboratory as :—

Chemists	2
Physicist	1
Engineer	1
Mechanics	2

National Library, Calcutta

No technical staff required.

Department of Anthropology

	Gazetted	Non gazetted
Anthropologists	25	38

Department of Education—Provincial

		Gazetted	Non gazetted
Orissa—	Physicists	2	4
	Botanists	2	4
	Zoologists	2	4
	Geologists	2	4
	Chemists and Mathematicians — not stated.		
Assam—	Industrial Chemists	18	244
	Botanists	4	..
	Zoologists and Physicists — Not stated.		

East Punjab

No. not stated.

(The Department has just started functioning and it has been stated that they need Organic Chemists, Biochemists, Agricultural Chemists and applied Physicists).

We summarise the above requirements as :—

	Engineering Degree or Equivalent	or Post Graduate in Science	
Physicists	77+24+1081=1182		
Chemists	92+40+1081=1213		
Industrial Chemists	18+247=265		
Mathematics and Statistics	104+201+1081=1205		
Biological Sciences personnel	76+28+1442=1546 (1442 consists of 721 Zoology and 721 Botany teachers)		
Meteorologists	40+20=60		
Geologists	70+24+721=815		
Metallurgists	41+20=61		
Archæologists	10		
Anthropologists	30+38=68		
Engineers.—			
Civil	107	29	
Building construction	96	16	
Mechanical	154	143	
Electrical	144	61	
Aeronautical	48+20=68		
Chemical Engineers	79+42=121		
Applied Mechanics	92+40=132		
Science Masters* (junior)	..	16220	
Science Masters(Intermediates)	..	..	182,296
			182,296

(*In the above 5407 Senior Science Masters have been apportionned among the Six basic Science Subjects *viz.* Physics, Chemistry, Mathematics, Botany, Zoology and Geology in the proportion 60 : 40 between the Physical Sciences and the Natural Sciences groups. The distribution among the 3 Subjects in each group is equal.)

Pattern of Employment and Training Facilities

260. The staff requirements for the departments of education may be assessed under two heads-those for teaching higher scientific and technical subjects and those required for teaching science subjects in schools. The former category must hold a post-graduate degree in the relevant science subject whereas for teaching science in schools usually Inter science B.Sc., and M.Sc. are required. They are usually given short training in the school itself or in one of the training schools.

261. Since the question of training facilities that would be eventually available in the Higher Technical Institutions has been considered inc hapter on Educational and Research Institutes, we are at this stage only concerned with training for the staff required by various departments for technical-cum-administrative work. For these posts the incumbents must hold a high degree in the relevant science subject together with post-graduate experience. In view of these considerations we have classified the staff requirements into three categories *viz.* degree holders with post-graduate experience, diploma holders or graduates and science teachers with intermediate standard (science) qualifications.

No special training facilities are available in the departments of education whether at the centre or in the province. The attached offices like Department of Archæology and Anthropology have special training facilities in excavation and preservation of antiques and anthropological work. The laboratory facilities available are usually of specialised type and as this training is not likely to be of use to other departments non-employees are not given training in these subjects.

Training Abroad

262. Some of the staff required for the proposed higher technical institutions will have to receive training abroad particularly in such subjects as Aeronautical Engineering, High Polymers, Fuel Technology etc. No information has been made available to us as to the probable number that will be trained abroad. We, however, estimate that at least 10% of the staff employed as Professors and Assistant Professors should receive training abroad. The number involved is about 128 for the four institutes, and for other departments as stated below :—

Department	Subject	Number
Orissa and Assam	Mathematical Physics	1
	Atomic Physics	1
	Plant Genetics	1
	Electron Microscope	1
	Protozoology	1
	Geology	1
	Nuclear Chemistry	1
	Organic Chemistry	1
	Systematic Zoology	2
	Ichthyology and Pisiculture	2
	Helminthology	1
	Agricultural Entomology	2
Bihar	Aerodynamics, Electronics, Micronics and radar, heat and power, drugs and paramaceuticals, electro-chemistry, biochemistry and analytical chemistry	16
Department of Anthropology	Advanced social and physical anthropology, and training in Psychometric and Psycoanalytical methods	15
National Archives of India	Preservation of Archives, Pictures and sound recordings, documentary production methods, processing and printing etc. (In addition there should be provision for the Scientific staff to visit sister institutes in foreign countries)	5
Archæological Survey of India	Spectro chemical analysis, advanced metallography, museum technique etc.	2
	TOTAL	181

Departments of Geology and Mines: Inspectorate of Explosives

263. Besides the Central Governments' activities in this field only the Mysore Government is maintaining a full-fledged department of geology and mines. Some States like Jaipur and Travancore had or have recently appointed qualified geologists to advise them on mineral prospecting and scientific utilization of the mineral resources of their territories.

Present Position

264. The main activity and scope of the Geological Survey of India and the department of Geology and Mines, Government of Mysore, is the preparation of accurate geological maps. Other activities cover laboratory research, drilling, mining and geophysical exploration, petrographic investigations, large scale mining and utilization of economic minerals including gold and Kaolin and other mineral products (Mysore) as well as investigations on economic utilization of lowgrade ores. Although the preparation of a geological map has been one of the primary functions of the Geological Survey of India for the last 95 years, there are some areas which have not been mapped completely. But the location of the most important mineral deposits is already known to the department. Some of the areas such as coal bearing areas have been surveyed exhaustively and 4" to 1 mile maps have been prepared. For a proper scientific mineral development of a particular mineral deposit may sections of the department, like drilling and mining sections and departmental laboratories such as Chemical, Petrological, Palentological and Geophysical collaborate to determine the optimum conditions of working. A Bureau of Mines with advisory functions to work in close co-operation with the Geological Survey of India has been established recently.

265. A Department of Mines is at present functioning under the Ministry of Labour for the inspection of various mines and to give technical advice on matters relating to mining and labour conditions. The Labour Bureau under the Ministry of Labour is responsible for—

(*i*) Collection and publication of statistics relating to labour ;

(*ii*) Maintenance of the Cost of Living Index Numbers,

and

(*iii*) Keeping up-to-date the factual data relating to working conditions collected by the Labour Investigation Committee.

266. It may be mentioned here that there are special organizations, *viz.* (*a*) the Office of the Chief Advisor of Factories (under Labour Ministry) and (*b*) the Office of the Chief Inspector of Explosives (under the Ministry of W M. P.), whose sole function is to give technical advice to various Government departments on :—

(*a*) Working conditions in the factories, factory construction, lighting and ventilation, temperature and humidity control, washing arrangements, sanitation, housing of labour, prevention of accidents and other safety precautions.

(*b*) Technical advice on handling, storage and transport of explosives, hazardous chemicals, petroleum and compressed gas cylinders.

Staff employed :—

The staff employed by various departments is as follows :—

Geological Survey of India :—

Staff employed	Officers	N.G.O.
Geologists	106*	21
Geophysicists	3	14
Mining engineers and Drilling Engineers	2	1
Physicists	—	—
Chemists	10	4
Department of Mines—		
Mining Engineers	12	..
Labour Bureau—		
Mathematicians and Statisticians	2	1
Department of Geology and Mines, Mysore.—		
Geologists	4	6
Geophysicists	1	1
Chemists	2	1
Supdt. and Asstt. Supdt. (Gold Mines)	2	

(*Includes 26 Assistant Geologists who have been selected for employment.)

	Officers.	N.G.O.
Travancore—		
Geologists	1	..
Mayurbhunj—		
Mining Engineers	3	..
Jaipur—		
Mining Engineers	3	..
Chief Advisor Factories—		
Engineers	4	..
Architects	1	..
Factory lay out expert	1	..
Chief Inspector of Explosives—		
Engineer	1	..
Chemists	13	..
	171	49

At present some posts in Geological Survey of India are lying vacant. Since these posts may be filled up in the current year, these have been taken into consideration in the additional staff requirements for the department's development and expansion.

Development plans

267. The development plans of the Geological Survey of India relate to general expansion of all its activities and reorganization of the department into 13 divisions, each division being under a circle officer and each being provided with a laboratory for preliminary testing etc. Surveying programmes have also been drawn for the next 5 to 10 years but it is likely that this may not be executed within this time. Work on mineral investigations is to be intensified and every attempt is being made to give increased assistance and advice to States and Provinces. It is hoped that eventually there will be field station equipped with a full-fledged laboratory in each province and major state.

268. The main objective of the development of the Department of Geology and Mines, Mysore, relate to undertaking systematic survey in the newly constituted divisions of the State; completion of geophysical survey in sulphide zone and radio active mineral's zone ; increased prospecting with selected deposits of minerals of industrial importance ; extension of gold mining and kaolin mining industry ; purification of low grade minerals for the manufacture of crucibles and other refractories materials ; asbestos products, and manufacture of sulphuric acid etc.

No details are available on the development of the Department of Geology, Travancore or the Department of Mines, Jaipur. Bihar Government, however, has made provision for the development of mineral resources of the province but no detailed information as been made available to us.

269. As stated earlier, the Bureau of Mines will start functioning in an advisory capacity and will mainly concern itself with forming the National Mineral Policy, but the actual mining and marketing of minerals will not be undertaken. It will, however, collaborate and co-operate with other scientific organizations in the country to obtain the necessary information regarding the statistical and analytical testing etc.

270. The development programme of the Department of Mines, the Chief Advisor of Factories, and the Chief Inspector of Explosives relate to exhaustive inspection of Mines, observance of safety protections, compilation of statistics etc. The development of the Office of the Chief Inspector of Explosives will be considerable in case it is decided to establish high explosive industry in the country. Proposals are being examined to this effect.

Staff Requirements

271. The staff required by the G. S. I. by 1951 to fill the vacancies in the existing strength is as follows :—

	G. O.	N.G.O.
Geologists	35	3
Geophysicists	1	3
Drilling Engineer	1	..
Chemists	1	..
Physicists	1	..

To fulfil the development programme the department has estimated the requirements as :—

	G. O.	N.G.O.
Geologists	103	19
Geophysicists	26	10
Drilling Engineers	7	..
Mining Engineer	1	..
Chemists	9	2
Physicists	1	..

Department of Geology and Mines—Mysore.—

Geologists	8
Metallurgists	1
Mining Engineer	1

The staff suggested for the proposed Bureau of Mines is—

Director	1
Dy. Directors	5
Asstt. Directors	5
Technical Asstts.	3
Foremen	2
Machine men	2

(This would comprise 8 Mining Engineers, 5 Geophysicists, 1 Drilling Engineer and 4 Mechanical Engineering diploma holders)

Labour Bureau	G.O.	N.G.O.
Statisticians	1	1

For the development of the office of the Chief Advisor of Factories and Chief Inspector of Explosives requirements for staff are stated to be 7 engineers, and six chemists (officers).

No information is available on the development of department of Geology in Travancore but as a result of our survey we feel that if the Department is to expand, it must employ more Geologists, Geophysicists and mining engineers.

272. Although mineral prospecting in most of the areas is being carried out by the Government itself, some private concerns who have taken mining leases and are busy in mining work do employ geologists and mining engineers for the purpose. We have no data regarding the number of such concerns, the scale of their operation and their requirements for personnel during the next five year period. We may, however, assume that for the improvement and expansion of these activities, the requirements for personnel for these non-official organizations may be about 20 geologists and 10 mining engineers.

The above requirements may be grouped as follows:—

Geologists (Post-graduate qualifications)	188
Geophysicists (Post-graduate qualification)	45
Mining Engineers (graduates)	20
Metallurgists (graduate)	1
Drilling Engineers (graduates)	9
Chemists (Post-graduates)	18
Mechanical Engineers (graduates)	7
Diploma holder (Mechanical Engineer)	4
Physicist (Post-graduate)	2
Statisticians (Post graduate)	2
TOTAL	296

Pattern of Employment and Training facilities

273. The bulk of the staff employed in the departments of geology and mines will comprise Geologists and Geophysicists and Mining engineers. Inorganic mineral chemists would form a complementry part. The need for imparting training in modern geophysical methods in mineral prospecting has now assumed great importance. Further, the staff employed must hold degree in geology or mining engineering with varying length of post-graduate experience in various allied subject. For instance, it is necessary for a mining engineer to hold a certificate of competency before he could find suitable employment. In view of this we have not classified the personnel into gazetted and non-gazetted ranks, as for the purpose of this assessment the minimum qualifications for both ranks would be those of graduates.

Training facilities.

274. The Geological Survey of India is well equipped with a petrological, chemical and geophysica laboratory and a museum for palenotological work. Proposals are under consideration for the establishment of an Ore-dressing laboratory for preliminary testing of Ores. The junior officers employed in the department are also given field training under the guidance of senior officers employed in the department who have acquired specialized knowledge.

This special training may be classified into :—

(*i*) Engineering geology and ground water.

(*ii*) Palaentology.

(*iii*) Petrology.

(*iv*) Field geology including structural geology.

(*v*) Geophysical prospecting.

Facilities for geological field work are also provided to the staff and a limited number of outsider (Post graduate students and members of staff of the Universities) during the field season. During the last season 8 post-graduate students were selected and given necessary training. It is likely that these facilities may be enlarged in the coming year.

The department of Geology and Mines, Mysore has somewhat similar training facilities. They are willing to provide training for 12 geologists during the field season and are trying to equip themselves with all the necessary appliances for electrical methods of geophysical surveying and prospecting. The facilities for training, therefore, are available for 20 students. These should be utilized fully and should also be increased considerably.

275. We would like to point out here that field training in all respects of geological and geophysical work has now been accepted as an essential part of the geological education of the country. There is at the moment no shortage of geologists but there is an acute shortage of well trained and experienced geologists.

276. We would like to state here the view expressed by the Director of Geology and Mines, Mysore regarding practical training of graduates in Geology. He has stated :

"Indian Universities do not at present provide appropriate field training. It is necessary that at least one year's field training must be made compulsory for B. Sc. Honours students in Geology before the degree is awarded. Necessary training in mineral chemistry should also be included in the syllabus in Honours classes in geology. There should be a proper co-ordination and liaison between the Geologcal Survey of India and the Department of Geology and Mines of provinces and states. This may be brought about by holding regular meetings of the representatives of these organizations every year and by finding out a co-ordinated plan of work for the whole country".

Training Abroad

277. In addition to the training facilities already existing in the country, it has been stated that it would be necessary to depute officers after a period of approved service for higher training and research in the following subjects :—

> Mineragraphy, petrofabrics; ore dressing, X-ray crystal structure and spectroscopy, radio activity, micropalæontology ; engineering geology, water resources, seismology, palaebotany including micro-palæobotany, motamorphic geology ; structural geology, vertebrate petrology, geogphysical prospecting ; drilling, Geo-chemistry Cermic and refractories, solid and liquid fuel, cement and road building materials.

The number of persons to be deputed abroad in any particular year has, however, not been specified. Even if one officer is deputed abroad for each subject the number to be sent abroad annually would be about 20.

The department of geology and mines, Mysore and Travancore have indicated that their require ments for training abroad are :—

Geophysical survey	3
Mining	3
Metallurgy and more dressing	3

The Chief Inspector of Explosives has no separate departmental laboratory and he can only give training to a comparatively few persons on handling, storage and transport of explosives and other hazardous chemicals. The Department is of the opinion that 5 officers should be trained abroad in the next five years.

The Chief Advisor of Factories arranges departmental courses for the training of personnel employed on factory inspection. So far 2 courses have been held and it is hoped that this activity will be increased. The Chief Advisor has stated that 3 officers should be sent abroad for training in the next 5 years.

Total—117.

*Medical and Public Health Departments***

278. It is well-known that the present state of public health in India is very poor, that the prevalence of diseases is large and the rate of mortality consequently very high, particularly amongst such vulnerable age groups as children under 10 years and women in the reproductive age period. Of the total number of annual deaths at all ages nearly one-half takes place among children under 10 and, of the total deaths under 10, approximately half the number occurs among infants below one year of age. About 2,00,000 women die every year as a result of childbirth and 4 million more suffer to varying extents from disabilities resulting from causes due to childbirth. Diseases such as Malaria (100 million suffer and 2 million die annually), tuberculosis (2.5 million cases and 5,00,000 deaths per year) and other infectious diseases like cholera, small-pox and plague are responsible for a very large part of the mortality in the Country. In addition, endemic diseases such as leprosy, filariasis, guinea-worm and hook-worm are also responsible for great morbidity in the community as a whole.

279. Both in the urban and rural areas, the Medical and Public Health Departments of Porvinces and of Indian States bear the main responsibility for providing hospital facilities and other forms of medical relief to the people. The distribution of these facilities vary from area to area but the quality of service rendered leaves much to be desired. The need for providing adequate medical relief to the rural population n the rural areas and for introducing suitable health measures is urgent.

** The Ministry of Health have not so far completed and returned the questionnaire issued by the Committee.

Institution	Scope of activities
1 King Institute, Guindy, Madras.	Research on tropical diseases and Public Health problems such as water bacteriology and sewage water purification. Training of personnel for the Government of Madras in various aspects of Public Health Works.
2 Pasteur Intitute, Coonoor.	Manufactures anti-rabic serum and conducts research on virus diseases in all aspects, such as bacteriological, clinical and pathological.
3 Nutrition Research Laboratory, Coonoor.	Conducts basic research in the science of nutrition and its application in field trials. Training of personnel in nutrition work.
4 Haffkine Institute, Bombay.	Researches on Plague, manufacture of Plague, Cholera, T. A. B. and Anti-Rabic vaccine and anti-toxin and Sera. Training Centre for Medical and Public Health Officers and Sanitary Inspectors in anti-plague measures.
5 Central Military Pathological Laboratory, Poona.	Training of commissioned medical officers of the Army and research of certain aspects of health and prevention of diseases as applicable to the Army.
6 Malaria Institute of India, Delhi (Ministry of Health)	Combined teaching and research Institute. Undertakes fundamental research bearing on malarial transmission, its prevalence and prevention, systematic study of malarial mosquitoes, malarial parasites, epidemiology of malarial and clinical aspects. Training of personnel for anti-malarial work.
7 Central Research Institute, Kasauli	Undertakes manufacture of vaccines, sera and other biologicals and carries out research on serum standardization and on virus diseases.
8 All India Institute of Hygiene and Public Health, Calcutta.	Combined teaching and research institute for Public Health Administration, epidemiology, nutrition, industrial hygiene, sanitary engineering, maternity and child welfare, etc. The department is also maintaining a rural training centre.
9 School of Tropical of Medicine, Calcutta.	Combined teaching and research institution for tropical medicine-pathology, helminthology, entomology, etc. Training facilities in tropical diseases. Research bearing on kalasar, leprosy, diseases of the bowel, filariasis, diabetis, tropical diseases and standardization of indigenous drugs.
10 King Edward Memorial Pasteur Institute, Shillong.	Manufacture of Cholera and T. A. B. vaccine, Bacteriophages. Service as Bacteriological and Bio-Chemical Laboratory for the Province. Undertakes research work also.
11 Central Drugs Laboratory, Calcutta.	Analysis and testing of samples sent to the laboratory under the provisions of the Drugs Act ; standardization of Drugs Act, preparation, maintenance and distribution of drugs of standard strength ; purity and equality of drugs ; research work on pharmaceutical testing of drugs.

adequate medical relief to the rural population in the rural areas and for introduction suitable health measure is urgent.

280. The promotion of medical education forms also a part of the normal activities of the medical departments of the Central, Provincial and States Governments. They maintain a number of medical colleges as well as institutions of medical and public health research. We have under "Medical Education and Research" outlined in some detail the present position regarding medical education and research in the country. We have also in the same section dealt with the research activities of the various special institutions such as the Malaria Institute, School of Tropical Medicine, Pasteur Institute, etc. In the following is given a brief summary of the activities of those research establishments which are administered or sponsored by Government. It is to be noted that the activities of these institutions constitute quite a significant part of the entire activities of the Public Health Departments of Governments Central and Provincial.

Of the several Medical ond Public Health Departments in the country, only a few have replied to our questionnaire. These are the Medical and Public Health Departments of Madras, Travancore, Bombay, Gwalior, West Bengal, Orissa, Bihar, and Jaipur and the special institutions mentioned above.

STAFF EMPLOYED

281. Full particulars of the staff employed in all the Medical and Public Health organisation establishments in the country are not available. In the following however, is given whatever information has been furnished to us in this respect.

Name of Government	Category of Personnel	Gazetted	N.G.O.
Madras Medical Department	**Medical Personnel**	**434**	**14**
	Other Technical Personnel, such as Pharmacists, Dentists, Chemical Examiners, Analysts, Public Health Personnel	**15**	**98**
Madras Health Department	**Health Personnel**	**194**	**410**
	Entomologists	**1**	**27**
	Health Engineers	**2**	**6**
	Chemists	**1**	..
King's Institute Preventive Medicines	Chemists	6	15
	(Organic and Biochemists)		
	Biological Sciences Personnel	1	2
	Medical Personnel	18	3
Mysore Public Health Department	Medical Sciences	13	110
Travancore Medical Department	Medical Personnel	84	15
Cochin Government Public Health Department	Medical Personnel	5	16
Travancore Public Health Department	Medical Personnel	11	..
	Biochemists	..	3
Bombay Medical Department	Medical Personnel	216	307
	Public Health Personnel	51	..
	Chemists	4	..
	Biological Sciences	2	..
	Unclassified Tech. Personnel	16	..
Gwalior Medical Department	Medical Personnel	54	1
West Bengal Government	Medical Personnel	5	17
	Chemistry	25	23
	Bio-chemistry	2	4
Orissa Government	Medical Sciences	69	145
	Public Health	15	33
Bihar Government	Medical Personnel	153	98
Malaria Institute, Delhi	Medical Personnel	15	..
School of Tropical Medicine, Calcutta	(Employs 6 Professors, 7 Asstt. Professors and 5-part-time lecturers)		
	Medical Personnel	13	..
Central Research Institute, Kasauli	Medical Personnel	6	...
	Biochemists	1	..
Pasteur Institute, Coonoor	No information given		
Nutrition Research Laboratory, IRFA	Biochemists	3	1
	Medical Personnel	4	..
All India Institute of Hygiene and Public Health	Medical Personnel.	18	..
	(Professors 7 Associate, Prof. 2 Asstt. Prof. 9)		
	Research Assistants	..	26
East Punjab Medical Department	Medical Personnel	117	284
U. P. Govt. Public Health Department	Engineers—Civil	25	42
	Engineers—Mechanical	2	2
Jaipur Govt. Medical Department	Medical Personnel	54	53

The staff employed in all these organizations may be classified as :—

	Gazetted Officers	Non-gazetted Officers
Medical Personnel	1289	1089
Chemists	36	38
Biochemists	6	8
Public Health Personnel	260	443
Biological Sciences (Entomologists)	4	29
Engineers—Civil	25	42
Engineers—Mechanical	2	2
Engineers—Health	2	6
Unclassified personnel (Technical)	31	98
TOTAL	1655	1755
GRAND TOTAL	3,410	

Development Programme

282. The Provincial Health Department plans generally envisage improvement of medical and public health facilities as well as of facilities for medical education in the respective provinces or states. It is proposed to improve the hospital facilities both in quality and in extent. Addition of bacteriological laboratories, dental clinics, and venereal disease clinics, etc., is proposed in such of the hospials as do not have these facilities at present. General increase in the number of beds in hospitals in rural areas is also proposed. As regards the development plans relating to medical education and research, these have been considerred in detail in the relevant section. In the following is given a brief account of important features of the development plans of the medical departments of the various Provincial Governments and Governments of Indian States.

Government of Madras

283. The Medical Department of the Government of Madras envisages establishment of two regional research laboratories on the lines of the parent institute at Guindy ; improvement of medical education in existing colleges and opening of two nursing colleges ; expansion of medical relief by opening 150 combined medical and public health centres during the first five years ; improvement of Taluk Headquarters and District Headquarters Hospitals ; provision for 100 additional beds in each of the two existing tuberculosis hospitals and establishment of a new tuberculosis sanatorium ; expansion and development of King's Institute, Guindy, and introduction of measures to control, prevent and treat leprosy. The above schemes have been drawn up in accordance with the development plans approved by the Centre.

The Madras Public Health Department envisages increased activities in the application of preventive and public health measures. Training of additional public health personnel at the Central Malaria Laboratory and at the regional laboratories is proposed. Other aspects relate to provision of public health services both preventive and curative, for the industrial workers and their families, detailed survey of the nutritional possibilities of food grains chiefly available in various areas with a view to planning a balanced diet and thus avoiding morbidity arising out of nutritional deficiency improvement of conservancy and sanitation arrangements.

Travancore Government

284. Proposes to expand the facilities available at the five hospitals in the State so as to be able to treat all diseases. Efforts are also being made to provide additional hospital accommodation in the tuberculosis, mental, laprosy and ophthahalmic hospitals. It is also proposed to establish tuberculosis clinics in all important towns and villages of the State.

The Public Health Department of Travancore proposes improvement of the system of registration and compilation of vital statistics, organizations of industrial hygiene, rural sanitation, establishment of centres for mid-wifery training malaria control, tuberculosis control, V. D. control, increase in the number of health units and extension of protected water supply to rural areas. Establishment of a medical college in Travancore with an initial annual intake of 40 students is also contemplated.

Government of Bombay

285. The development plans relate to improvement in medical education ; opening of Colleges of Nursing at Poona and Ahmedabad ; training of personnel in nutrition work in U. K. ; establishment of Medical Colleges at Poona and Ahmedabad ; increasing the number of beds in district headquarters hospitals ; training of a number of technicians for X-ray and laboratory work ; establishment of tuberculosis hospitals ; leper homes and an infirmary at Bombay.

Gwalior Government

286. Proposes to extend medical aid to rural areas by establishing Ayurvedic dispensaries in small villages and allopathetic dispensaries in larger villages. Subsidised dispensaries for groups of smaller villages are also proposed. Improvement of equipment in State hospitals for diagnostic and treatment purposes as well as establishment of a Research Laboratory during the next 10 years have also been contemplated.

West Bengal Government

287. Contemplates improvement of nursing system and establishment of Bengal Nursing Service improvement of pharmacy and pharmoceutical training ; provision for an infectious diseases hospital and a children's hospital at Calcutta and a mental hospital at Ranchi. Establishment of 2 leper clinics, subsidy to medical practitioners ; provision for protected water supply in rural areas ; malaria control and provision for tuberculosis hospitals at Assansol and Midnapur are other aspects of the development plan.

Orissa Government

288. Development plans contemplate training of technicians and health inspectors ; improvement of district headquarters' dispensaries ; general expansion of medial relief ; improvement of nursing services ; and expansion of maternity and child-welfare centres. It is also proposed to establish a Midwifery Training School at Berhampore, a tuberculosis sanitorium and a mental hospital. Anti-leprosy, anti-malaria and anti-filaria schemes will be introduced in rural areas.

The Malaria Institute of India

289. Envisages investigations on effective and economical methods of malaria control in rural areas, malarial chemotherapy and investigations on use of synthetic drugs for malarial immunity.

School of Tropical Medicine, Calcutta

290. Contemplates pansion of research activities and increase in the intake of students to the D. T. M. Course from 50 to 100.

Central Research Institute, Kasauli

291. It is understood that a proposal is being considered to re-organise the Institute for the manufacture and standardization of sera and other biologicals.

Pasteur Institute, Coonoor

292. It is proposed to intensify work on the cultivation of rabic virus in vitro. Comercial production of the highly potent anti-rabic vaccine developed in the laboratory is also contemplated.

All-India Institute of Hygiene & Public Health

293. Proposals are being considered to expand almost all the sections of the Institute. It is also proposed to add a food technology section for research on some of the food problems such as bacteriological standards, food preservation and transport. Training of personnel in sanitary engineering, nutrition and physiological hygiene is also proposed.

U. P. Government

294. It is proposed to reorganize many of the existing water works so as to meet the demand of the increase in population and to supply protected water to 8 new towns during the next 5 years and to 65 new towns during the subsequent 10 years. It is also proposed to supply protected water to rural areas in accordance with the recommendations of the Bhore Committee. The drainage system of cities will also be improved during the next 5 years.

Jaipur Government

295. Propose to develop fully the newly established medical college and extend medical facilities in the districts.

Staff Requirements

296. We give below the staff requirements for the various medical and public health orgnizations other than the medical colleges. The details have been furnished by the respective departments.

	Gazetted	Non-gazetted
Medical Department, Madras Government		
Medical Personnel	271	..
Chemists	4	..
Public Health	6	..
Public Health Department, Madras		
Medical Personnel	29	..
Health Officers	25	..
King's Institute, Guindy, Madras		
Medical Personnel	6	..
Science Graduates	12	..
Mysore Public Health Department		
Medical Personnel	73	170
Medical Department, Travancore		
Medical Personnel	50	..
Public Health Department, Travancore		
Medical Personnel	4	..
Malariologist	1	..
Medical Department, Bombay		
Medical Personnel	72	288
Public Health Department, Bombay		
Medical Personnel	5	..
Public Health Personnel	10	..
Gwalior Medical Department	No information given.	
West Bengal		
Medical Sciences	6	7
Chemistry	17	9
Bio-chemistry	1	..

Category	Gazetted	Non-gazetted
Orissa		
Public Health	19	29
Medical Sciences	17	35
Bihar		
Medical Sciences	14	..
Malaria Institute		
Medical Personnel	24	..
School of Tropical Medicine		
Medical Personnel	12	..
Mechanics	..	1
Central Research Institute	Not stated	
Pasteur Institute, Coonoor		
Medical Officers	2	..
Laboratory assistants	..	4
Nutrition Research Institute, Coonoor	Not stated	
All India Institute of Hygiene & Public Health	Not stated	
U. P. Public Health Department		
Engineers—Civil	7	24
Engineers—Mechanical	1	3
Jaipur Government Medical Department		
Medical Personnel	2	..
East Punjab Medical Department		
Medical Personnel	44	148

These requirements may be summarised as :

	Gazetted	Non-gazetted
Medical Personnel	632	660
Public Health Personnel	60	49
Chemists	34	9
Public Health and Sanitary Engineers	8	..
Total	734	718

297. It is to be admitted that the development plans described above provide a very unsatisfactory basis for the assessment of the requirements for medical and public health personnel for the whole country during the next 5 or 10 years periods, particularly in view of the fact that the plans do not cover the needs of the whole country in the matter of medical facilities. We have, therefore, to consider other plans and in particular the Health Development Plan formulated by the Health Survey & Development Committee set up by the Government of India under the chairmanship of Sir Joseph Bhore. The Bhore Committee plan envisages the extension of adequate medical facilities and health protection to every section of the people of the country—rural as well as urban without distinction within the next 25 years and covers all aspects of curative and preventive medicine, public health, nutrition, occupational and industrial workers health service, health services for children and pregnant women, medical education and researeh, etc. The plan consists of two parts ; one a comprehensive long term project for the next 25 years and the other a short term project covering the next 10 years in two stages of 5 years each.

298. The long term project centres round a District Health Organisation, linked with the general organisation and administration of health services at the centre and in the provinces. Each District Health Organisation will cater for the medical and public health needs of 3 million people and whole plan is consequently referred to as the "three million plan".

The District Health Organization will have as its smallest unit of administration, the Primary Unit, normally to serve an area with a population of 10,000 to 20,000. A number of such primary units (15 to 20) will together constitute a Secondary Unit, and about 3 to 5 secondary units will form a district health unit, the designation by which the District Health Organization will be known. At each of the headquarters of the districts, secondary and primary units will establish a Health Centre, which will act as the focal point for all health activities for the area covered by each. Hospital facilities will also be provided at each of these centres. For instance, the district health centre will possess a general and special hospital with a total bed strength of 2500 and will maintain consultant and laboratory services required for the diagnosis and treatment of diseases on modern lines. The seondary health centre will be provided with hospital accommodation of about 650 beds with equipment and other suitable facilities on a generous scale, whereas each primary health centre will each have a 75 bed hospital and it is from these primary centres that the health administration will operate in the rural areas. The long term project is schematically represented as shown below :—

LONG TERM PROGRAMME

Provincial Minister of Health

Director of Health Services

District Health Organisation

(THREE MILLION PLAN)

District Health Board

Officer in charge of District Health Services

Distt. Health Council

District Health Centre

Administration

Environmental Hygiene (Public Health Engineer)

Hospital Service, 2500 bed hospital, with out-patient department.
(Medicine, surgery, Obstetrics & Gynaecology, etc. Special provision for research and laboratory service of a high order.

[Population 600,000 each Secondary Units (5)]

Secondary Health Centre

Administration

Environmental Hygiene (Assistant Public Health Engineer)

Hospital service, 650 bed hospital, with out-patient department.
(Medicine, Surgery, Obstetrics and Gynaecology, etc.) Laboratory service for the secondary unit as a whole.

(Population 20,000 each)

Primary Unit (30)
Primary Health Centre.

Administration (Each Unit divided into four circles)

Environmental Hygiene (Public Health Inspectors, Health Assistants and field staff)

Hospital service 75-bed hospital with out-patient department. (Medicine, Surgery, Obstetrics and Gynaecology, etc.)

Demiciliary service, Proventive and Curative.(Home visiting by doctors, public health nurses. mid-wives for marernity & child-we fare work, school health, tuberculosis work, etc.)

299. When the long term scheme is taken in hand trained personnel of various types will be required during the next 25 years to man the health services. The Committee has worked out the requirements for various categories on the basis of the ratio of trained personnel to population as is generally prevalent in other countries. The figures are :—

Class of personnel	Number available now	Ratio of numbers in Col. 2 to the present population of British India (300 million)	Existing ratio in the United Kingdom	Suggested ratio to be attained in 1971 in British India with estimated population of 370 million	Number required in 1971
Doctors	47,500	1 to 6,000	1 to 1,000	1 to 2,000	185,000
Nurses	7,000	1 to 43,000	1 to 300	1 to 300	740,000
Health Visitors	750	1 to 400,000	1 to 4,770	1 to 5,000	74,000
Midwives	5,000	1 to 60,000	1 to 618	1 per 100 births	100,000
Qualified Pharmacists	75	1 to 4,000,000	1 Pharmacist to 3 Doctors	1 Pharmacist to 3 Doctors	62,000
Qualified Dentists	1,000	1 to 3,000,000	1 to 2,700	1 to 4,000	92,500

NOTE.—The Committee made these calculations on the basis of the then existing population of 300 millions in British Indian. Since then India has been partitioned. The present population of Indian Union and acceding states may be taken approximately as 300 million. The rate of population increase, roughly 3 million per year, may also be taken as increase in population of the Union. The figures arrived at in this case will, therefore, apply with a reasonable degree of accuracy to the present and future population of Indian Union.

300. The short term project which has been made to supplement and not to supplant the existing health services only presents a general picture of guidance for the provinces. In the opinion of the Committee the various recommendations in this respect are the barest minimum if any visible results are to be achieved during the next 5 to 10 years' period. The plan includes proposals for the establishment of personal and impersonal health services. Under the former head a province-wise organization has been proposed for combined preventive and curative health work. For instance, for a population of 3 million there should be a district health organization. Under this Organizatien there should be a number of primary and secondary units and special health services for mothers and children, school children and industrial workers, as well as for dealing with important diseases prevalent in India. In view of the insufficiency of funds and shortage of trained personnel, it has been suggested that each primary unit should serve during the first ten years a population of 40,000, and that each primary health centre should have a dispensary with 4 beds and that the secondary health centre should start with 20 beds hospital which should be raised gradually to 500 beds by the end of the 10th year. The establishment of the district health centre, it is suggested, be postponed until after this period. In order to expand the existing hospital facilities in rural areas it has been suggested that a 30 bed hospital should be established at the start to serve 4 primary units, and by the end of ten years this number should be doubled so that each unit will serve two primary units. Under the District Health Organization also there should be only one or two secondary health centres and maximum of 25 primary units.

The organisational set up of the short-term project is schematically shown below :—

SHORT TERM PROGRAMME

PROVINCIAL MINISTER OF HEALTH

Director of Health Services

District Health Organization
(Three Million Plan)

District Health Board—Officer in charge of District Health Services—District Health Council

Secondary Units (1 to 2)
Secondary Health Centre

Administrative Medical Officer

Administration

Environmental Hygiene
(Assistant Public Health Engineer)

Hospital Service
200 bed or 500-bed hospital, with its out-patient department.
(Medicine, surgery, Obstetrics and Gynaecology etc.)
Laboratory service for the Secondary unit as whole.

(Population 40,000 each)
Primary Units (upto 25)

Primary Health Centre

Administration
(Each Unit divided into 4 circles)

Environmental Hygiene

Hospital Service
1. One dispensary with two emergency beds and two maternity beds.
2. One 30-bed hospital to serve 4 primary units during 1st five years and 2 units during next 5 years.

Domiciliary service, curative and preventive.
(Home visiting by doctors, public health nurses, midwives for maternity and child-welfare work, school health, tuberculosis work, etc.)

In the short-term programme the establishment of the organization at the district headquarters is not contemplated. The administrative and supervisory functions exercised by the staff at the Secondary Health Centre will be on the lines indicated for the long term programme.

301. Since in the context of this report we are concerned only with the next 10 year-period, the short-term project of the Committee is of importance to us. The following table summarises the expansion of health services in a typical district (3 million population) during the first ten years according to the short-term project.

	First year	Fifth year	Tenth Year
Number of primary Units	5	10	25
Number of dispensaries	5	10	25
Number of 30-bed hospitals	1	2	13
Number of secondary units	1	1	2
Number of 200-bed hospitals	1	1	1
Number of 500-bed hospitals	..	..	1

Assuming that the population of the Indian Union was 300 millions in 1947, the population would be approximately 315 millions in 1951 and 330 millions in 1956. For the development of the health programme over the whole country in the next 5 and 10 years, the number of various units will be :—

	5th year	10th year
Number of primary units	1050	2750
Number of dispensaries	1050	2750
Number of 30 bed hospitals	210	1430
Number of secondary units	105	220
Number of 200 beded hospitals	105	110
Number of 500 beded hospitals	..	110

equirements for Staff

302. Owing to general financial stringency in the country none of the Provinces has adopted the recommendations of the Bhore Committee *in toto.* Though the general principles underlying that Committee's plan have been accepted by all these Governments, the post-war development plans suggested by them fall far short of the Committee's recommendations. Besides, individual Provinces have been modifying their own schemes from time to time during the last three years. Hence Provincial development plans can hardly be taken as the basis for an assessment of the requirements for medical and ancillary personnel for the country as a whole. It is, therefore, considered desirable to give only the total requirements as assessed by the Bhore Committee. The estimate for doctors and nurses required at the end of the first five years and first ten years as given by the Bhore Committee is as follows :—

Estimate of Doctors Required at the end of first five years and first ten years.

Medical Colleges		First five years		First ten years
The estimate for a medical college has been based on the suggestions put forward by the Goodenough Committee, namely, for preclinical subjects 69 and for clinical subjects 119 in each college.				
Total required	188 × 24 =	4,512	43 × 188 =	8·084
Primary Unit:				
2 Doctors for each primary unit	2 × 1952 =	3,904	2 × 3905 =	7,810
30 Bed hospital : 1 Doctor each	1 × 404 =	404	1 × 1990 =	1,990
Secondary Unit :				
3 M. O.'s for each secondary unit	3 × 216 =	648	3 × 355 =	1,065
200 Bed hospitals : 15 Doctors for each	15 × 216 =	3,240	15 × 216 =	3,240
500 Bed hospital	..	..	15 × 139 =	2,085
Mobile, dental organisations	..	..	1 × 355 =	355
District headquarters organisation : two doctors for each	2 × 216 =	432	.. =	432
Central Directorate	..	21	.. =	21
Provl. Dte. Tuberculosis 5 Doctors for each	20 × 11 =	220	.. =	220
200 bed hospital 1 : 40	5 × 33 =	165	5 × 66 =	330
Main clinics 3 for each District clinics	3 × 33 =	99	3 × 66 =	198
2 for each Travelling Tuberculosis clinics	..	..	1 × 710 =	710
Mental diseases :				
1 Doctor for 50 beds : 9,000 new beds in each period	..	180	..	360
Malaria : Headquarters	..	44	..	44
Deputies	..	..	..	22
Control Unit, 10 for each province	10 × 11 =	110	25 × 11 =	275
Leprosy :				
14,000 beds, 1 doctor for 40	..	350	..	700
Venereal diseases :				
Provinces	5 × 11 =	55	10 × 11 =	110
Districts	1 × 216 =	216	2 × 216 =	432
School health :				
2 for each province	2 × 11 =	22	4 × 11 =	44
Nutrition :				
5 for each Province	5 × 11 =	55	..	55
Total		15,043		29,314

Estimate for nurses for hospitals and dispensaries required at the end of first five and first ten years.

Primary units dispensaries	1952 × 1 =	1,952	3905 × 1 =	3,905
30-bed hospitals : 8 nurses per hospital	404 × 8 =	3,232	1,990 × 8 =	15,920
Secondary Unit :				
200 bed hospitals 50 nurses per hospital	216 × 50 =	10,800	216 × 50 =	10,800
500 bed hospitals 125 nurses per hospital	..	..	139 × 50 =	17,375
HOSPITALS ATTACHED TO MEDICAL COLLEGES				
1,000 beds in each and 250 nurses	250 × 24 =	6,000	250 × 43 =	10,750
Tuberculosis				
200 bed hospital for every centre, each hospital will have 20 nurses	33 × 20 =	660	66 × 20 =	1,320
Travelling tuberculosis clinics :				
one nurse in each	..	*Nil*	710 × 1 =	710
Mental				
9,000 new beds in each period, 1 nurse for 20 beds	..	450	..	900
Leprosy				
To provide for 14,000 beds in each period ; 1 nurse for 20 beds	..	700	..	1,400
Total		23,794		63,080

Public Health Nurses for Outdoor duty

Primary Unit						
Public health nurses per unit	1952 ×	4 =	7,808	3905 ×	4 =	15,620
Secondary Unit						
2 Senior public health nurses per unit	216 ×	2 =	432	355 ×	2 =	710
Tuberculosis						
Three public health nurses for every main clinic	33 ×	3 =	99	66 ×	3 =	198
Two for every district clinic	183 ×	2 =	366	366 ×	2 =	732
School health nurses for every Province	11 ×	1 =	11	22 ×	1 =	22
Total number of nurses required (Public health nurses and hospital nurses)			8,716			17,282

Employee's State Insurance Act

303. The Employees State Insurance Act passed by the Dominion Parliament in 1948 provides for medical treatment and attendance to insured workers in case of sickness, injury, maternity. The scheme is compulsory and contributory and will cover an estimated 2½ million workers in the perennial factories in India. Wherever there is an insured population of over 2,000 persons residing within an area of 16 sq. miles, medical care should, it is envisaged, be provided through a full time Insurance Medical Officer and as a corollary no full time Medical Officer should be required to look after more than 2000 patients. Thus, for an estimated 2½ million workers in perennial factories in India, the State will require the services of 1250 doctors, to give effect to the Act.

Private Practice

304. In assessing the requirements for medical personnel we should take into consideration "Private Medical Practice", which attracts a considerable number of medical graduates from institutions. There is no satisfactory basis for determining the number of doctors likely to take to this branch of the profession during the next 5 or 10 year periods. It is understood that about 80% of medical graduates go into private practice at present, this high percentage being chiefly due to lack of suitable jobs under the Government and the Public authorities and the attraction of larger monetary benefits, which private practice holds. The health department and other schemes outlined above will, however, offer great scope for employment of medical personnel in the years to come and consequently the drift of doctors into private practice will be considerably less than what it is now. At the same time such drift will not cease completely for obvious reasons. We may assume that during the next 5 years about 35% of the medical graduates passing out of the colleges take to private practice. It has been estimated elsewhere in the report that the total outturn of medical graduates in the country during the next 5 years will be about 5940. 35% of this *i.e.* about 2085 doctors, it may be assumed, would go into private practice for the next 5 year period. For the subsequent 5 year period also the number will be more or less the same

305. In the following is presented an overall picture of the requirements for medical and other health personnel during the next 5 and 10 year periods for the various development projects outlined in paras. 274—293 above. This consists of two parts, one relating to the requirements, particulars in respect of which have been furnished by the Government Departments, and the other to the assessment made for the short-term Health Development plan of the Bhore Committee, the Workmen's State Insurance Act Scheme and the Private Practice. It is to be noted that if a comprehensive view is taken of the needs for medical and health services, the first part merges into the second part.

REQUIREMENTS FOR MEDICAL AND PUBLIC HEALTH PERSONNEL

PART I.—*Requirements as per details furnished by Government Departments*

Category	Number Gazetted	Number Non-gazetted
Medical Personnel	632	660 (All graduates)
Public Health Personnel	60	49
Chemists	34	9 (Post graudates)
Public Health and Sanitary Engineers	8	....
	734	718

Part II.—*Requirements for the Bhore Committee Plan, Workmen's State Insurance, etc., and Private Practice*

Category	Requirement for the next 5 years	Requirements for the first 10 year period
Doctors including specialists (All graduates as the mininnum qualification	18,378	33,959
Dentists	180	355
Nurses	32,510	90,362
Total		

Training Facilities

306. We have in the section on Medical Education and Research dealt in detail with facilities for post-graduate training and research in Medical and allied sciences. Here we shall only refer to facilities available for training in certain special branches in Government and Government-sponsored departments.

The Public Health Department of Provinces have or are planning to have Industrial Hygiene Bureaus and regional industrial health offices, which will be in a position to train health officers and health inspectors. The Malaria Institute of India trains Provincial Health Officers in anti-malaria work. It has also facilities for the research training of about four candidates in Malarial Entomology.

The School of tropical Medicine, Calcutta, and the All-India Institute of Hygiene and Public Health, Calcutta, train personnel in tropical medicine and public health respectively. Details of the training courses are reported elsewhere in this report.

The Public Health Laboratory, Calcutta, provides training facilities in chemical analysis on food stuffs, chemical and bacteriological analysis of water.

The Pasteur Institute and the Central Research Institute, Kasauli, are at present functioning only as manufacturing and research centres but available facilities can be utilized for the training of personnel in certain aspects of virus diseases.

It is understood that in order to provide training facilities for Public Health Engineers, who would be required in large numbers to implement the various post-war plans, both urban and rural, such as water supply, drainage, sewage work, construction of houses, factories, hospitals, sanitoria, etc., the Government of India through the courtesy of the Calcutta University have recently introduced a course in Master of Engineering (Public Health) at the All-India Institute of Hygiene and Public Health, Calcutta. The course which is open to candidates possessing a recognised degree in engineering extends over a period of about 2 years which includes practical training in selected areas.

Training abroad

307. From the replies to the questionnaire received from the various Government Departments it is clear that almost all the departments are of the opinion that graduates should be sent abroad for advanced training in various branches of medicine and public health. On the basis of the recommendations of the Bhore Committee which stated that an endeavour should be made to send about 200 selected members of the medical profession in India from the various Provinces to countries abroad to acquire a knowledge of the up-to-date methods of teaching and research in their respective subjects, a medical scholarship scheme was initiated by the Health Ministry of the Government of India in 1946 in collaboration with the Provinces. So far 145 medical graduates have been sent abroad under this scheme and 48 more have been selected this year to be sent as soon as their placements abroad are obtained.

The Ministry of Health, on further consideration of the scholarship scheme, has decided not to send out any more recently qualified graduates. On the other hand, they feel that persons occupying key posts in the country's Health Services, including those employed in teaching institutions, should be sent periodically on travel fellowships for acquainting themselves with the latest developments in different medical specialities. It is considered that this scheme should be continued and that at least 20 persons should be sent abroad on such travel fellowship annually.

We should like to refer here to Foods and Drugs Control which is of great importance to the maintenance of the health and safety of the people. In all civilized countries of the world, undesirable and harmful traffic in drugs and foods has been checked by the rigid enforcement of Foods and Drugs Act by Governments. No drug or medicinal preparation, the efficacy of which is open to grave suspicion, or which contains ingredients calculated to be injurious to health, can find its way into the market and any manufacturer trafficking in such products is considered to be infringing the law of the state and is liable to severe punishment. Same is the case with the preparation and sale of Food and Food products which are injurious to health. In India however, such control measures are sadly lacking and the volume of traffic in harmful and spurious drugs and medicinal prepartions in the country is alarmingly large. It is on the increase due to the illiteracy of the masses who are "taken in" by the methods of advertisement adopted by the traffickers. Food products are prepared and sold in a way which violates all rules of hygiene and, constitutes the single largest source of infectious diseases. The tragedy of the situation is that such traffic in drugs and foods has not been made illegal in the country, let alone enforcing measures to prevent it. It is not necessary to dilate here on the various aspects of the resultant consequences. Suffice it to say, that the health of the people is being seriously endangered. Recently, the Government, it is understood, have been contemplating enacting the Foods and Drugs Control Act. We do not know at what stage the proposal is now, but hope that before long the Act will be passed and strictly enforced. The matter is important and urgent and brooks no delay.

The strict enforcement of Foods and Drugs control measures entails establishment of official laboratories all over the country for the scientific testing and certification of product sold to the public. In some Provinces, such laboratories are already functioning, but the scope of their work is limited. Every province and every major Indian State should have a principal laboratory fully equipped for chemical, biological and bacteriological examination of Foods and Drugs sold in the market—and one regional or field laboratory in every district or for each municipality. On this basis, the total number of laboratories required for the whole country would be about 20 principal laboratories and 300 regional laboratories. This is the absolute minimum and the actual requirements on the basis of one regional laboratory for every Municipality or District would be much more. The technical staff of each principal Foods and Drugs Control Laboratory would consist of 6 senior men—1 pharmacologist, 1 bacteriologist, 1 medical examiner and 3 chemists or analysts with specialised training in bio-chemistry and in the analysis of Foods and Drugs—and 12 junior analysts or chemists with training in Foods and Drugs analysis. Each regional laboratory would consist of 1 senior analyst and 2 junior analysts. The total staff required for the 20 principal and 300 regional laboratories would be as follows:—

Principal laboratories

20 Pharmacologists
20 Bacteriologists
20 Medical Examiners
60 Senior Analysts (Chemical and Biological)
240 Junior Analysts (Chemical and Biological)

Regional laboratories

300 Senior Analysts
600 Junior Analysts

The training of the above personnel, especially the analysts—both senior and junior—in the analysis of Foods and Drugs should be organised in institutions, as well as in the Public Health Departments of Governments. At present, training in the subjects is provided only in 3-4 institutions in the country and that too for a very limited number of candidats and the available. facilities are wholly inadequate. It is, therefore, necessary that training courses in the analysis of Foods and Drugs should be organised n several other institutions in the country to meet our require ments for trained personne'.

Summary Statement

Requirements

308. In this section we furnish summarised statements on the Scientific and Technical man-power employed by various departments of the Central and Provincial Governments and their requirements for scientific and technical personnel in the next 5—10 years. In subsequent sections we have summarised the training facilities available in Government Departments and the views expressed by the Departments on such questions as standardization of training, leakage and drift, salary and status of scientific and technical staff.

Present Employment

309. The Government Departments together employ 34,019 scientific and technical personnel 11,855 and 22,164 in gazetted and non-gazetted posts respectively, as shown below:—

TABLE I

Name of Department	Gazetted	Non-Gazetted	Total
Communication—			
Posts and Telegraphs	349	1,087	1,436
Indian Meteorological Department	135	1,400	1,535
Civil Aviation	331	18	349
Rail Transport	1,146	1,604	2,750
Mercantile Marine	48	..	48
Port Trusts	107	45	152
Roads Organization	27	48	75
Radio and Broadcasting	74	212	286
Departments of Public Works	2,101	6,759	8,860
Departments of Electricity	429	1,313	1,742
Government sponsored Research Organisations	31	76	107
Departments of Industries, Civil Supplies and Development	740	724	1,464
Departments of Revenue	30	42	72
Departments of Agriculture	1,404	3,891	5,295
Departments of Education	259	127	386
Departments of Geology and Mines	185	52	237
Departments of Medical and Public Health	1,655	1,755	3,410
Defence Establishment	2,804	3,011	5,815
	11,855	22,164	34,019

Additional Requirements

310. All the Departments have not classified the requirements according to their specialised need and in such cases an attempt has been made to classify the personnel requirements, as far as possible keeping in view the nature of work or the basic qualifications of the entrants. The requirements are:—

TABLE II

Name of Department	Gazetted	Non-gazetted	Total
Communicaionst—			
Posts and Telegraphs	152	250	402
Indian Meteorological Department	89	343	432
Civil Aviation	526	52	578
Rail Transport	620	975	1,595
Mercantile Marine	2,794	...	2,794
Port Trust Organisation	28	10	38
Roads Organization	400	2,000	2,400
Radio and Broadcasting	112	455	567
Departments of Public Works	2,842	8,715	11,557
Departments of Electricity	299	624	923
Government sponsored Research Organisations	986	56	1,042
Departments of Industries, Civil Supplies, Development	1,788	232	2,020
Departments of Revenue	10	..	10
Departments of Agriculture	2,437	4,155	6,592
Departments of Education	6,795	17,030	23,825 (Inter Science 182,296)
Departments of Geology	314	4	318
Departments of Medical and Public Health	10,300	22,180	32,480
Defence Establishment	8,325	..	8,325
Total	38,817	57,081	95,898 (+ 182,296 inter Science

311. These requirements may be classified as:—

TABLE III

	Gazetted officers	Non-Gazetted officers
1. Physicists	1,060	248
2. Chemists	1,760	447
3. Science Master (All Physical Science)	5,407	16,220
4. Mathematicians and Statisticians	262	139
5. Biological Sciences	419	146
6. Zoologists	110	249
7. Agricultural Sciences	1,593	2,168
8. Geologists and Geophysicists	328	34
9. Metallurgists	249	20
10. Technologists (All categories)	428	721
11. Medical Personnel	11,356	83
12. Public Health Personnel	8,910	..
13. Veterinary Surgeons	487	567
14. Non-medical personnel (auxiliary)	12,915	..
15. Engineers (All categories)	18,489	10,633
16. Unclassified Technical Personnel	392	58
Total	64,165	31,733
	95,898	
17. Inter Science (Science teachers)	1,82,296	

NOTE.—In those cases where classification amongst gazetted officers and non-gazetted officers has not been possible, the staff requirements have been taken under Gazetted Officers.

SUMMARY REPORT

Training facilities in Government Departments

312. It would be noticed from Table No. III that for Government Departments alone the requirements of engineers, chemists, agricultural scientists and medical personnel are by far the heaviest. Since the training period of this type of personnel lasts for 3—4 years after the Intermediate Science Standard it will be necessary to make immediate arrangements for the expansion of facilities for education upto Intermediate Standard, if the requisite number of students are to be forthcoming for higher studies. The Intermediate Science and the B.Sc. (Pure Sciences) students generally, are the students who go for the higher scientific and technical education. Their outturn (1947) from the existing colleges is:—

Intermediate in Science	19,660
B.Sc. in pure Sciences	4,792
	24,452

313. With the limited resources available it is obviously necessary to utilize the present facilities to the maximum extent, *i.e.* such conditions be created that the drift or leakage is entirely eliminated. Even if this is achieved successfully it is necessary, in our opinion, to increase at least 4 times the training facilities at the Intermediate Science Standard.

314. We have indicated in the context of this report the training facilities available in the Government Departments and established industries of the country. We will summarize here the number of trainees that, in our opinion, can be trained by various Government Departments. All the departments do not have the necessary facilities at present. We believe that with slight additions to equipment and possibly to staff and implementation of development projects, the facilities can be created in the next few years. There is no denying the fact that the existing training facilities are extremely meagre. We will not discuss here the merits of practical training but will only point out that the development

programme of the industries and government departments is, to a large extent, dependent on a steady supply of trained engineers, scientists, and technicians. We, therefore suggest that the existing facilities be utilised to the maximum extent and additional training facilities created as indicated below.—

Department	Subject	No. that may be taken for training
1. Posts and Telegraphs Department.	In telecommunication engineering for personnel employed in the the department only.	40
2. Director General, Observatories	In meteorology and weather forecasting	50
3. Director General, Civil Aviation	Aeronautical Engineering tele-communication, navigation, ground engineering etc. Training operators in radio radar technique. The school at Saharanpur caters to the needs of civil aviation. In case of an emergency the R.I.A.F. can draw on this source.	50
4. Railways	Training facilities for mechanical engineering, and other subordinate services. apprentices for various posts in Railways 150 in workshops 30 in labourities facilities for training of apprentices in general mechanical & structure electrical engineering metallurgy etc. can be arranged at various workshops and laboratories under the Railway Board.	
5. Training ship "Dufferin" . .	Marine Engineering and executive officers . . .	80 for nautical personnel (1949 on wards.
6. Mercantile Marine . . .	Ditto ditto	80 for engineering (annual intake) and 100 on board ships.
7. All India Radio . . .	Communication Engineering and telecommunication . . .	100
8. Public Works Department .	Air conditioning, design of dams, building construction, irrigation projects, soil investigations, drainage works hydraulic research.	400
9. C.W. I. N. C. and theirex perimental stations.	Hydrology and hydraulic research, design and construction of dams	25
10. Electricity Deptt. . . .	Electrical Engineering, high voltage transmission, maintenance of sub-stations.	163
11. C.S.I.R. Laboratories . .	General chemistry, plant products, plastics, paints, oils and fats, etc.	20 (at present)
12. Government Test House . .	Testing, certification and general analytical work . . .	15
13. Coal Commissioner to Govt. of India.	Mining Engineers	2
14. Mathematical Instrument Office	Mechanical engineering and production engineering . . .	10
15. Sindri Fertilised Factory .	Mechanical engineering in various sections of the plant at present. Subsequently in chemical engineering and technology also.	25 Graduates in Engineering. 75 trade apprentices.
16. Chemical Laboratories Central Board of Revenue.	General analytical work and examination of drugs and alkoloids .	5
17. Survey of India . . .	In topographical survey, maps, preparation, magnetic and other surveys.	Not possible with present facilities. If necessary, arrangements should be made for the training of 10 Students.
18. Zoological Survey of India .	Animal ecology zoology	6
19. Central Ground Water Organization.	In drilling technique (A school has been started recently) .	5
20. Indian Veterinary Research Institute.	In animal genetics, nutrition, fodder and veterinary sciences .	12
21. Central Marine Fisheries Research Institute.	In fisheries, marine biology oceanography, etc. . . .	6 (from 1949 onwards)
22. Indian Dairy Research Inst., Bangalore.	In dairy sciences, nutrition of milch cattle, animal husbandry, bacteriology, etc.	9
23. Indian Agric. Research Inst. .	Research in agricultural sciences, agronomy, plant pathology .	50
Defence Establishment		
Ordnance Factories .	Apprenticeship training as assistant works managers, improvers or journeymen and apprentices (a scheme has been proposed in 1947 to train 160 apprentices).	250
Ordnance Laboratories . . .	Ordnance and Military stores training and research . . .	60
Inspectorate of Military Explosives	Testing and research on explosives	8
Metallurgical Inspectorate . .	Testing and metallurgical research	10
		1,852

315. This list is to be supplemented by training facilities available in the Government research organizations, such as Haffkine Institute, Bombay. Forest Research Institute, Dehra Dun and the National Laboratories of the C.S.I.R. when fully established (*vide* chapter on Education & Research).

Overseas Training

316. The Government of India sponsored an Overseas Training Scheme about 3 years ago. So far about 720 Indian students have been selected and sent abroad. Since last year the scheme has been held in abeyance. The scheme was initiated at a time when the Western Universities and technical institutes were themselves very short of accommodation for their nationals. In spite of this the Government secured with great difficulty certain number of seats in the educational institutes but it was almost impossible to arrange for the practical training of the students who had qualified from foreign institutes. Some of these students have started coming back after training and the problem of providing suitable occupation for these students is now engaging the attention of the Government.

317. In view of the experience gained during the last 3 years the period during which this schem has been functioning, the Government appointed a Committee under the Chairmanship of Dr. B. C. Roy to advise them on the overseas scholarships scheme. In their interim recommendations the Committee has stated that it will be desirable to expand the scope of the overseas scholarship scheme so as to embrace the needs of the Government Departments, educational institutes and industries and other subjects such as Humanities. The number of scholars will necessarily become large. In view of the limited accommodation available they have suggested that a list of priorities be drawn up according to which numbers to be sent abroad for various subjects should be selected each year. Further, they feel that the fresh graduates should be allowed to work in India for a period of one to two years before they are considered for being sent abroad. To implement this suggestion they have suggested that a scheme for auxiliary scholarships tenable in India be initiated. The Committee has also suggested a new method of selecting students for overseas training.

318. The past experience regarding the overseas training scheme has shown that it is extremely difficult for our State scholars to obtain practical training abroad. Since this training forms an important part of the general educational qualifications of the State scholars it is necessary that some other means should be adopted to overcome this difficulty. It has been suggested by many leading industrialists that it will be desirable to impart practical training to the selected trainees in the respective fields in India for a period of six months to one year, so that the student going abroad for higher studies becomes conversant with practical aspects of the work and are in a better position to take advantage of the foreign education. In so far as personnel from industries is concerned a number of concerns have suggested that as far as possible persons already employed in various industries should be selected for studies abroad, if they have the requisite educational back-ground. If possible, eminent professors from abroad be invited to train our nationals in the country.

319. It has been mentioned by a number of Government departments, educational institutes and industries that it is necessary to send students for training abroad in a number of subjects. So far as the educational institutes are concerned, they were asked to indicate the subjects in which students have to be trained abroad. From the replies received it appears that the training abroad is necessary in almost all the subjects. Since it may not be possible for the Universities to spare their staff for a prolonged course of study at a foreign University or research institute, we feel it would be better in the present circumstances if the Universities and research institutes were to adopt the system of deputing their staff for short-term tours to foreign countries. It will enable them to obtain a first hand information on the latest and improved methods of teaching and various aspects of scientific and technical research in which the individual professor or research worker is interested. The requirements of 20 Universities and other special research institutes may, however, be assessed at about 800 scholars who may have to be sent abroad during the next five year period for regular course of studies in all scientific subjects.

320. So far as the industries are concerned we have indicated elsewhere in the report the number of students that have to trained abroad. Since information on this important subject is not available from all the industries, we mention here that all the Industrial Panel Reports have drawn attention to lack of suitable qualified personnel and they have recommended that 1670 students be trained abroad in the next 5 years for various industries excluding iron and steel, refractories and ceramics, leather technology, heavy chemicals, fine chemicals, drugs and pharamaceuticals, electrical machinery and equipment, machine tools and automobile industries. We estimate that the number of students to be sent abroad for these industries may be taken for the present assessment at 650 during the next 5 years, distributed as follows:—

		No. per year
Heavy Chemicals and electro chemicals	Fertilisers (1), Research in catelysis and corrosion (2), Chlorinated compounds (4), Instrument Technology (1) Chemical Engineering (3) ,Industrial furnaces (1), Factory Safety and handling of chemicals (1).	13
	Electro thermic reactions (calcium carbide, Magnesium aluminium, abrasives, etc. (15) High pressure synthesis (Urea and related compounds) (5).	20
Fine Chemicals Pharmaceuticals and Drugs.	Chemo-therapeutic & synthetic drugs (5), glandular products (2), Catelytic synthesis of fine chemicals and solvents (2), general pharmaceutical preparations (2), Antibiotics (7), Chemical biological and Pharmacelogical assay (2), manufacture of dye stuff Intermediates (4), High and low temperature carbonisation of coal and recovery of bye-products (4).	28
Leather Technology	Scholar need not be sent abroad for general leather processing but it isnecessary to send people for advanced research in leather technology (2).	2
Non-ferrous metals	Production Engineering (2), Heat treatment (2), Resistance alloys (1), rolling and allied shop practice (3), alloy welding and foundry practice (3).	10
Iron and Steel	Production Engineering (4), Alloy Steel (2), Rolling and allied workshop practice (4).	10
Machine Tools	Lathes (1), Milling Machine (1), gauges (2), Hydraulic machines(2).	6
Electrical Machinery and equipment	Pelton reels (2), steam generator, etc. (4), Starters and switchgear (2), insulating materials (4), radio acid electronics (4),Lamps (mercury vapour, phosphorescent lights, Radio valves) (4), testing and standardisation (2), instruments and thermostatic controls (4), production Engineering(4).	30
Automobiles and Tractors	Recording instruments (2), Plug manufacture (2)	4
Refractories and Ceramics	Special refractories (2) Foreman design and production engineering (2).	4
	Ceramic potteries (2), production engineers (1)	3
	Total	130
	Five years' requirements	650

321. A number of Government Departments, Central as well as Provincial, have pointed out the need for training their staff in foreign countries. The subjects of training have been mentioned in detail in this respect. The number of persons to be trained abroad, as suggested by the departments are:—

Name of Department	No. to be sent abroad in 5 years
Communications—	
Posts and Telegraphs	Own arrangement.
Indian Meteorological Deptt.	40
Civil Aviation	126
Rail Transport	120
Roads Organisation	20
Radio and Broadcasting	40
Public Works Departments	328
Electricity Departments	171
Departments of Geology and Mines	117
Government sponsored research organisations	154
Deptts. of Medical and Public Health	138
Departments of Agriculture	828
Departments of Education	181
Departments of Industries, Civil Supplies and Development	148
Departments of Revenue	3
Defence Establishment (3 years)	768
	3,182

322. The total number of students to be sent abroad in the next 5 years to meet the requirement of the Government Departments, Industries and Educational Institutions, therefore, is:—

Educational Institutes	800
Industries	2,320
Government Departments	3,182
Total	6,302

323. It is obvious that the training of all these persons would involve a colossal expenditure on the part of the Indian Government. Even if the Government were prepared to undertake this expenditure, the present difficulties of obtaining accommodation in Western Universities and Technical Institutes will certainly limit the numbers to be sent abroad. We have, therefore, to consider other means whereby training abroad is obtained only in certain essential aspects of scientific and technical education and research. So far as industry is concerned, we have been informed that the Ministry of Industry and Supply, in consultation with industries, has drawn up a list of the number of trained persons of foreign nationalities who have to be brought into the country for various industries. Their number is 188 and the details are as follows:—

Industry	Scientists High Grade	Experts	Works Managers	Others	Total
1. Abrasive	..	..	..	1	1
2. Ceramics	2	1	1	2	6
3. Chemicals and Drugs	15	..	2	16	33
4. Distillery	2	..	1	..	3
5. Electrical	1	..	5	6	12
6. Enamel	3	2	..	3	8
7. Glass	1	1	6	17	25
8. Leather	3	..	1	4	8
9. Mechanical Engineering	2	..	8	9	19
10. Metal	2	..	2	6	10
11. Paints	11	1	3	10	25
12. Paper	..	..	..	1	1
13. Plastic	..	..	3	10	13
14. Rubber	1	..	3	8	12
15. Silk	2	..	..	..	2
16. Tools (Machine)	..	..	1	6	7
17. Woodware	1	..	1	1	3
Total	46	5	37	100	188

If the usual practice of attaching three or four understudies to each foreign expert is adopted, we can easily train over 200 men in the various industrial fields.

324. The shortage of accommodation in foreign Universities and research institutes is likely to continue for some years to come. It is, therefore, necessary that the entire policy of training our nationals overseas be so orientated that the minimum number is sent abroad, particularly for studies in those subjects in which facilities in India are totally lacking. These subjects are: Marine Engineering, Naval Architecture, Aeronautical Engineering, high pressure technique, gaseous centalytic reaction, etc. It is also necessary to provide training centres and research facilities for these subjects at the earliest, even if highly qualified foreign teachers have to be brought on very high salaries.

Unemployment, drift and leakage

325. It was considered necessary to ascertain the extent of unemployment, if any, among scientific and technical personnel. From figures obtained from the Director General of Resettlement and Employment, the total number of unemployed on 31st May, 1948, was as follows:—

Draftsmen, tracers and surveyors	539
Overseers	419
Engineers	858
Aeronautical Personnel	24
Marine Engineers	18
Wireless Mechanics	70
Posts & Telegraph subordinate engineering personnel	886
Cinematographers	128
Foremen and chargemen	646
Geologists	8
Chemical technologists and chemists	196
Metallurgists	34
Mining Engineers	3
Textile Technologists	65
Medical Personnel	274
Public Health Personnel	200
Dentists	11
Nurses	268
Auxiliary Non-Medical Personnel	26
Veterinary surgeons	12
Forest Officers	24
Agricultural Sciences	91
Total	4,800

326. Of these unemployed a large proportion, more than 70%, would appear to belong to the technician category. As for the rest there is no method for ascertaining whether they possess qualifications as to come under the purview of the Committee's terms of reference. It also happens that a fair proportion of the unemployed find employment but do not inform the Employment Exchanges. Therefore, it is not possible to say from these figures as to how many out of the above have the necessary qualifications and are actually unemployed. In view of these and other considerations, such as, the unprecedented migration of population it is not possible to draw any conclusion from these unemployment figures.

327. At the instance of the Scientific Man-Power Committee, the National Institute of Sciences have carried out a survey of scientific talents available with a view to assessing unemployment, "drift" or "leakage" of scientific personnel. A total of 2,291 persons have responded to the advertisement, which was given due publicity in the scientific journals and daily newspapers. The Hon'ble Prime Minister also issued a statement urging the scientists and technical persons to register their names. From the replies received so far by the National Institute of Sciences it appears that a total of 278 are employed in professions for which they are not originally trained and that 796 are unemployed. The details are as follows:—

TABLE NO. I

	Unemployed	No. employed in non-scientific occupation	Total registered
(a) Foremen type of personnel	91	24	287
(b) B. Sc.'s in pure Sciences (maximum qualifications)	98	110	610
(c) B. Sc.'s (maximum qualifications) (Applied Sciences)—			
Agric.	19	20	118
Ch. Tech.	143	39	250
Geology	26	..	52
Mining	3	..	10
Metallurgy	24	..	57
Engineers—			
Civil	27	7	120
Mechanical	44	5	138
Electrical	38	4	115
Other Cat.	23	3	44
(d) M. Sc.'s or Higher Qualifications—			
Agriculture	10	6	43
Chemistry	89	20	412
Maths.	16	10	63
Physics	54	19	238
Botany	12	6	85
Zoologists	12	2	52
Chem. Tech.	22	1	93
Geography and Geophysics	..	..	4
Engineers	5	..	25
(e) Medical Licenciates	5	2	27
(f) Medical graduates or higher qualifications	33	..	147
Total	796	278	2,291

328. An individual questionnaire was also circulated along with the questionnaire relating to Industries, Government and Government-sponsored Departments and Educational Institutes. So far we have registered a total of 8117 individual questionnaires (24-7-48). About 1500 forms are awaiting registration. The number of persons unemployed in various categories and the numbers employed in non-scientific occupations are as follows :—

TABLE NO. 2

	Un-employed	No. employed in non-scientific occupations	Total registration
1. B. Sc. in Pure Sciences	24	148	1,904
2. B. Sc. (Applied Sciences)			
Agriculture	2	2	271
Chemical Technologists	1	1	22
Geologists	..	..	116
Mining	1	..	53
Metallurgy	2	1	97
3. M. Sc. or higher qualifications			
Agriculture	..	..	42
Chemistry	2	5	585
Mathematics	2	16	163
Physics	4	4	248
Botany	3	4	209
Zoologists	2	..	187
Chemical Technologists	..	..	5
Geography & Geophysics	..	..	13
4. Medical Licenciates	2	..	54
5. Medical graduates or higher qualifications	9	..	533
6. Engineers—Graduates or higher qualifications	88	..	2,361
7. Engineers—Diploma-holders	48	..	1,254
Total	190	181	8,117

329. It is safe to presume that even though out of the total 10,408, scientific personnel who have furnished particulars 986 *i.e.* nearly 9·5% are unemployed, the total unemployment amongst those who have not responded would be much less for one would expect the unemployed to respond first.

330. A reference to tables 1 and 2 above would indicate that the proportion of drift or leakage taken in the broad context of the total number of scientific and technical staff employed is relatively small. It appears to be slightly higher in the case of those who have B. Sc. as the maximum qualification. We discussed this question with a number of distinguished educationists and they were of the opinion that the drift at the B. Sc. stage is usually very high, rising to as much as 50% in some cases. This is not surprising since B. Sc. in most cases is a qualifying degree preparatory to higher scientific studies and the facilities for such studies are very limited. We need not, however, feel undue anxiety on that score since science graduates also should be employed in non-scientific occupations where they will try to bring to bear their scientific outlook or methods on general problems. We are of the opinion that much benefit would accrue from a wider diffusion of scientific knowledge and methods through all sphere of activity, provided sufficient number of technical men can be spared. The drift from amongst personnel above B. Sc. stage is very slight and is due to the general unsatisfactory conditions of work in teaching and scientific occupations and the generally lower salaries and fewer privileges offered for technical posts as compared to administrative posts.

331. The cost of training students in Science subjects is comparatively high and if a person thus trained leaves the scientific work for administrative or non-scientific profession for monetary gain or position, the money and effort spent on his training are generally a loss, except in such cases where such men may find themselves in a position where they can bring to bear on administrative problems their sceintific outlook. Science and technology are to play a vital role in the future development of India's resources for the benefit of the country and its nationals. Keeping in view the shortage of scientific and technical persons in the country, we feel that it will be in national interests if this drift is minimised as far as possible. It is therefore necessary that the main causes leading to this drift *viz.* inadequate salary, inferior status and disparity of priveleges amongst technical and administrative posts should be eliminated. For otherwise our progress will be retarted.

Views regarding utilization of talent for the balanced development of the country

322. Government departments numbering 98 have not expressed any opinion on the utilization of scientific and technical talent in the country to the best advantage over the whole field of national activities. Some departments out of these have not replied to this question as they feel that it is a matter of policy and should be referred to the parent administrative department or the Ministry concerned. The remaining departments numbering 88 have expressed their opinion and have made certain suggestions which may be summarized under one or more of the following :—

(*a*) That a National Register of all scientific and technical personnel of the country be prepared. This should contain record of experience and the special training that the registered men have received. The Register should be kept up-to-date.

(*b*) That a pool of central scientific and administrative services be created and the most suitable persons be deputed to develop new field of activity in any part of the country.

(*c*) That a list of priorities for new manufactures be drawn up and a balanced training scheme be planned to meet these requirements year by year. This work, many departments feel, should be entrusted to a specially constituted Standing Committee.

(*d*) That industrial development of the country should be planned on the broadest possible basis even though some of the industries are not remunerative enough for the capitalists to invest their money.

(*e*) That the scientific and research activities of the country should be increased considerably. A central co-ordinating authority should ensure that there is no duplication or wastage of effort in any particular field.

(*f*) That there should be an arrangement to ensure an equitable distribution of candidates who are qualified and willing to take up careers in applied sciences and technology. This distribution should be proportionate to the demand for trained personnel from industries, Government Departments and research organizations.

(*g*) That the present tendency of crowding in a few branches of study to the detriment of other branches should be discouraged. An advisory board in each province, and one at the Centre, should be set up to collect information and data and help the Government during the next 10 years in the matter of proper selection and equitable distribution of personnel.

(*h*) That a Central body be established to draw up a priority list of subjects on which immediate attention should be focussed keeping in view the requirements of a free and progressive State and the facilities of training available in the country. The members should be drawn from the Departments of the Government, principal industries, Universities, Learned Societies and public men.

(*i*) That the factors causing the drift of technically trained men from scientific and technical profession to non-technical services should be removed.

(*j*) That the salaries and conditions of service of various technical service should be such as to attract the most suitable candidaes for the technical services in preference to administrative services.

333. We may point out here that these are the considered opinions of a large number of highly placed technical officers even though in some cases the Ministries concerned or the administrative departments concerned have preferred not to reply. Each of these is an important consideration and will govern to a large measure the future development of the country.

Standardization of training

334. Uptil now 186 departments of the Central and Provincial Governments have completed and returned the questionnaire issued by the Committee. Out of these 129 departments constituting some of the most important employers of scientific and technical personnel, such as, the Director General of Observatories, the Director General of Civil Aviation, the Geological Survey of India, the Council of Scientific and Industrial Research and the Indian Council of Agricultural Research, etc., are very strongly in favour of standardization of engineering and scientific training. For achieving this end a number of suggestions have been made which may fall under one or more of the following :—

(*a*) That Central Government Inspectorate be created to ensure that uniform training facilities are available, not only on paper but in actual practice, and that a specially constituted Committee may draw out blue prints in co-ordination and co-operation with the Inter University Board.

(*b*) That the Inter University Board be expanded so as to meet the present needs.

(*c*) That a new Committee be set up with the representatives of employer departments, teachin institutions and Learned Societies.

(*d*) That provincial governments be afforded the fullest representation on any such committee and the training facilities available in provinces may be extended to other provinces on reciprocal basis. The standardised training should, however, have slight flexibility so as to permit adjustment to local conditions.

(*e*) That the training in engineering and applied sciences must comprise both theory and practice Since there is dearth of suitable facilities for practical training, a standardized practica course for graduates should be established. This may be run by the Universities and Colleges in collaboration with Organized industrial groups through their Chambers of Commerce or associations of particular industries.

335. A number of departments feel that if these suggestions are accepted by the Government, the proposed organization should be entrusted with sufficient executive powers so that it may be able to enforce its decisions on the institutions concerned.

336. Government departments numbering 56 have not expressed any opinion on this question Only one Government Department has opposed this measure.

337. A very important issue arising out of the standardization of training is the lack of practical bias in our educational curriculam. This is due to the absence of co-ordination between academic education and the profession. It is a matter of common knowledge that in some technical institutions, the professors and lecturers have not been closely associated with large engineering projects or have very little conception of the difficulties faced by industry. Only "bookish" knowledge is passed on to the students year in and year out. Engineering, medicine and other scientific subjects are the most important courses of study in which the students should be kept in continuous touch with the latest developments whether on the theoretical side or on the practical side. In our opinion, it is necessary to work out an arrangement whereby the senior officers of engineering departments, scientific organisations and the technical heads of well established industrial concerns could be utilized for the training of students. Such an arrangement, while improving the standard of training, will also relieve to some extent the acute shortage of teachers and professors in various scientific fields.

Salaries and status

338. The heads of the Government departments we contacted were of the unanimous opinion that the status of scientific workers engaged in Government Departments is in general inferior to that enjoyed by those in the administrative services. Due to the relegation of scientists to a status subordinate to that of administrative officers, it has been difficult to secure the services of suitably trained and experienced men for implementing the development projects of Govt. Deptts.

339. As regards salaries and prospects of promotion about 188 departments of Central and Provincial Governments have advocated the adoption of a more rational policy regarding the salary, allowance and other emoluments to scientific and technical personnel. Only three departments of the Government have expressed their satisfaction over the salaries scales recommended by the Central Pay Commission. The salaries obtaining in Provincial Governments vary from Government to Government and in some cases there is a great disparity in the salaries offered in different departments of the same government for the same type of personnel. Such a practice is responsible for a considerable amount of "drift" from one Department of the Government to another and from the Provincial to the Central Government. Some of the departments almost always suffer from lack of trained and experienced staff. This in particular applies to the Zoological Survey of India, the Research Stations of the Central Waterways, Irrigation & Navigation Commission, Medical department, various departments of Agriculture, particularly those of Veterinary Sciences and Dairy Sciences. The scientific and technical staff have to spend 3—4 years more in their training before they qualify for a particular appointment and their chances of promotion to higher services are so small that talented students do not prefer to study scientific subjects and even if they do study these subjects they try to take their chance in the administrative service as their first choice. Many departments have expressed the opinion that if this drift to administrative services is allowed to go unchecked then within a very short period the proper type of personnel required for technical jobs may not be easily available.

To avert such a situation measures suggested are :—

(*a*) Adopting a uniform scale of salary for the various technical services under the Governments

(*b*) The salaries of these services should be better than or at least on par with the administrative services.

(*c*) Since equal chances of promotion are not available in the technical services they should be compensated with a special technical service allowance varying between 25 to 50% of the salaries.

340. A study of the information on salaries and conditions of service of the scientific and technical personnel as supplied by them on the individual questionnaires would be of great interest. From these questionnaires it appears to us that a very small number of technical personnel are receiving salaries of Rs. 1,000 or above and that a slightly greater number is getting salaries between Rs. 700 and Rs. 1,000. By far the largest majority of scientific and technical personnel, whether in industry or provincial governments or Central government, are getting salaries varying between Rs. 75 to Rs. 250. Cases are on record where qualified engineers have been offered a basic salary of Rs. 49 per month ! To say the least a continuation of the present tendency of paying lower salaries and according an inferior status to scientific and technical personnel will have a very deterimental effect on the development of the country. There can be no two opinions on the fact that the scientific and technical personnel have to take a leading part in the development of the country and national interest therefore dictates that men in these services should be kept contended by an offer of attractive salaries and terms.

DEFENCE ESTABLISHMENTS

Due to security reasons, we are afraid, we cannot deal with this Department in detail. However for purposes of assessing the requirements for scientific and technical man-power for all government and government sponsored activities including Defence, we give below our estimates of the requirements of various categories for sicentific and technical personnel for defence purposes during the next five year period. Column 2 indicates the requirements for normal defence and column 3 probable requirements in case of a national emergency.

Categories	Requirements for Normal defence	Probable Requirements in case of national emergency
Chemists	670	1,300
Physicists	290	600
Metallurgists	130	250
Meteorologists	70	200
Mathematicians & Statisticians	20	50
Biological Sciences	60	100
Textile Technologists	100	250
Engineers :		
Civil	1,000	1,500
Mechanical	980	2,000
Electrical	950	2,000
Tele-communication	420	900
Automobile	150	300
Military	600	1,500
Marine	630	1,000
Navigation	250	1,000
Armament	250	1,000
Aeronautical	500	1,000
Specialised training in weapons	300	1,000
Veterinary Specialists	50	150
Leather Technologists	25	100
Medical	630	1,000
	8,075	17,700

In the context of drawing up a forward educational development plan, we may take the latter figures into consideration.

Assuming that the 'Senior' and 'Junior' personnel in the Defence Establishments are generally in equal proportion, the requirements may be classified into two categories as shown below, one category comprising personnel with degree in engineering, medicine, technology or post-graduate qualifications in Science subjects as the minimum academic attainments and the other, personnel with diploma in engineering, technology or degree in Science subjects as the minimum academic attainments :

Personnel	No. Required Senior (Graduates in engineering, medicine, technology etc. and post-graduates in science subjects)	Junior (Diploma holders in Engineering & technology; Graduates in Science)
Chemists & Chemical Technologists	650	650
Physicists	600	..
Metallurgists	250	..
Meteorologists	200	..
Mathematicians & Statisticians	50	..
Biologists	100	..
Textile Technologists	125	125
Engineers :		
Civil	750	750
Mechanical	1,000	1,000
Electrical	1,000	1,000
Tele-communication	450	450
Automobile	150	150
Military	750	750
Marine & Navigation	1,000	1,000
Aeronautical	500	500
Armament	500	500
Weapon	500	500
Doctors	1,000	
Veterinary Specialists	150	
Leather Technologists	50	50

Summary Statement of requirements for Government and Government sponsored Activities

Category	Senior or Executive (Post-graduates in Science; graduates in Engineering, Technology, Medicine and Applied Sciences)	Junior (graduates in Science; Diploma holders or Licentiates, in Engineering, Technology & Applied Science
Posts & Telegraphs Department		
Engineers—Mechanical, Electrical & Tele-Communications	45	500
Chemist	1	
Metallurgist	1	
Intermediates in Science and above	500	
Indian Meteorological Department		
Chemists	10	70
Physicists	85	214
Mathematicians & Statisticians	18	60
Geologists & Geo-physicists	26	
Civil Aviation Directorate		
Engineers :—		
Tele-Communication/Radio	100	557
Civil	..	45
Mechanical	..	129
Aeronautical	26	..
Unclassified	12	..
Physicists	47	..
Doctors	2	..
Miscellaneous Technical personnel	..	230
Railways :		
Medical personnel (Doctors)	102	—
Chemists	13	—
Engineers :—		
Civil Engineers	525	586
Mechanical Engineers	180	59
Electrical Engineers	84	35
Mining Engineers	2	
Marine Engineers	1	6
Fuel Technologist	1	
Mercantile Marine		
Engineers—Mechanical, Electrical, Naval etc.	1,147	
Nautical personnel	1,647 (specially trained personnel)	
Port Trust Administration		
Civil Engineers	27	—
Mechanical Engineers	10	—
Electrical Engineers	1	..
Roads Organisation		
Civil Engineers (Highway Engineering)	900	1,500
Broadcasting & Information Films of India		
Tele-Communication Engineers or Electrical Engineers trained in Tele-communications	337	72
Physicists	50	
Cinematographic Experts	47	
Public Works Departments		
Civil Engineers	4,625	6,314
Electrical Engineers	281	376
Mechanical Engineers	136	99
Chemists & allied research personnel	44	..
Chemical Engineer	1	..
Soil Engineers & Soil Specialists	14	..
Medical personnel	52	..
Statisticians	4	..
Forest Officers	8	..
Physicists (Meteorologists)	6	..
Geologists	3	..
Architects	17	..
Zoologists	4	...
Agricultural Engineers	9	..

Electricity Departments		
Electrical Engineers	414	421
Mechanical Engineers	28	30
Civil Engineers	13	17
Department of Scientific Research and National laboratories		
Physicists :		
General and Applied	166	
Electricity	31	
Optics	14	
Heat & Power	19	
Electronics	15	
Pyrometry	3	
Chemists :		
Inorganic & General	273	
Organic	91	
Physical	62	
Electro-Chemistry	32	
Analytical	62	
Biochemistry	44	
Textile Chemists	29	
Mathematicians & Statisticians	17	
Agricultural Scientists	24	
Animal husbandry & veterinary specialists	13	
Biologists	23	
Metallurgists	39	
Fuel Technologists	32	
Glass & Ceramics Technologists	8	
Oil Technologists	6	
Textile Technologists	46	
Geologists	35	
Leather Technologists	4	
Engineers :		
Civil & Structural	54	
Mechanical & Hydraulic	102	53
Electrical	33	
Chemical	46	
Mining	4	
Automobile	12	
Aeronautical	10	
Textile	51	
Industries Supplies and Development Departments		
Chemists.	..	50
General and Applied	383	
Inorganic	7	
Organic	47	
Physical	10	
Analytical	15	
Biochemistry	27	
Physicists	288	
Botanists	2	
Biologists	75	
Sericultural Experts	73	
Statisticians	51	
Leather Technologists	42	
Geologists	3	
Agricultural Scientists	1	
Textile Technologists	41	
Medical personnel	5	
Metallurgists	22	232
Engineers :		
Civil	85	
Mechanical	359	
Electrical	132	
Chemical	51	
Mining	10	
Automobile	7	
Marine		
Central Revenue Deptts.		
Chemists		
Engineers :		
Mechanical		
Electrical		
Metallurgists		

Agriculture, Food, Forest, Fisheries & Animal husbandry Departments		
Botanists :	94	
Agronomy	36	
Plant Pathology	6	
Mycology	23	
Ecology	15	
Zoologists :	385	
Entomologists	84	
Heliminthologists	49	
Protozoologists	42	
Marine Biologists	70	
Fresh Water Biologists	70	
Marine Biologists & Fishery Experts	196	
Biologists	193	
Physicists	23	
Chemists & Chemical Technologists	215	
Statisticians	81	
Geologists	5	
Engineers :		
Civil	1	
Mechanical	38	32
Automobile	1	
Agricultural	45	
Fruit Technologists	24	
Food Technologists	14	
Animal husbandry specialists	98	
Forestry specialists	301	
Wood Technologists	32	
Agricultural specialists	2,611	507
Horticulturists	21	
Sericulturists	100	
Poultry Experts	40	
Dairy Scientists & Technologists	695	
Departments of Education		
Physicists	1,182	
Chemists	1,213	
Industrial Chemists	265	
Applied Mechanics Specialists	132	
Mathematicians & Statisticians	1,205	
Botanists	721	
Zoologists	721	
Biologists	76	
Meteorologists	60	
Geologists	815	
Metallurgists	61	
Archaeologists	10	
Anthropologists	68	
Engineers :		
Civil & Structural	203	45
Mechanical	154	143
Electrical	144	61
Aeronautical	68	
Chemical	107	29
Science Masters (Junior)	16,220 (graduates) 1,82,296 (I. Scs.)	
Deptts. of Geology & Mines & Explosives Inspectorate		
Geologists	188	
Geophysicists	45	
Engineers :		
Mechanical & Drilling	16	
Mining	20	
Metallurgists	1	
Chemists	18	
Physicists	2	
Statisticians	2	
Medical & Public Health Organisations		
Doctors and Specialist Medical & Public Health personnel	18,398	
Dentists	180	
Pharmacologists	20	
Bacteriologists	20	
Analysts (Chemical & Biological analysis of Food & Drugs)	360	840
Non-Medical Health Personnel	32,510 (Qualified Nurses)	
Defence Establishments		

As given in the statement on page 230.

Summary Statement of Requirments for Govt. and Govt. sponsored Activitie.

Category of Personnel	No. Required: Senior (Graduates in Engineering, Technology, Medicine & post-graduates in Science)	No. Required: Junior (Diploma holders in Engineering or Technology, Graduates in Science)
1 Engineers:		19,5[illegible]3
Civil & Constructional Engineers	7,183	
Mechanical Engineers	3,176	
Electrical Engineers	2,137	
Chemical Engineers	205	
Tele-Communication Engineers	887	
Automobile Engineers	170	
Marine Engineers & Naval Architects	1,004	
Aeronautical Engineers	604	
Mining Engineers	36	
General, Electrical & Mechanical and unclassified Engineers	1,881	
Architects	317	
2. Chemists & Chemical Technologists	3,884	1,610
3. Fuel & Furnace Technologists	33	
4. Metallurgists & Metallurgical Engineers	377	
5. Glass & Ceramics Technologists	8	
6. Geologists & Geophysicists	1,120	
7. Textile Technologists	212	125
8. Leather Technologists	96	50
9. Physicists	2,791	214
10. Botanists	897	..
11. Zoologists	1,425	..
12. Biologists	663	..
13. Agricultural Scientists	2,636	607
14. Mathematicians & Statisticians	1,560	60
15. Doctors	19,559	
16. Non-medical personnel (Nurses etc.)	32,510	
17. Dentists	180	
18. Dairy Technologists	695	
19. Unclassified and Miscellaneous Scientific & technical personnel	2,100	
20. Science teachers:		
Post-graduates in Science	Included under Physicists, Chemists, Botanists, Zoologists, Geologists & Mathematicians above.	
Graduates in Science		16,220
Intermediates in Science	182,296	
21. Intermediates in Science as technical personnel after training	500	

EDUCATION AND RESEARCH

SECTION III

1. We have in the preceding sections attempted to indicate in some detail the trends of development in industrial and other fields of activity in the country during the next five years and to estimate the requirements for scientific and technical personnel for the various projects.

2. In the following sections we present a co-ordinated picture of the existing educational facilities and indicate in particular the present outturn of personnel in the various subjects and of different categories and also make a forecast of the total number of personnel likely to be produced during the next five years under the existing circumstances. An attempt has also been made to analyse in some detail the schemes contemplated for the development of the educational and research institutions in the country and the consequential increase in the outturn of personnel in the years to come as and when these development schemes come to fruition.

The necessary data have been collected from a survey of each of the institutions in regard to the courses of study, the intake and outturn of students, the position in respect of adequacy or otherwise of staff, equipment and building accommodation and particulars of the development of expansion plan, if any. The views of the Heads of the Institutionshave also been obtained on a number of issues, such as drift or leakage of scientific talent, procurement of scientific equipment, collaboration with Industry, need for training of Indian personnel abroad etc. Analytical statements prepared in respect of each of these institutions may be seen in appendix.

Engineering and Technology

3. Engineering and technological institutions may be divided into three broad categories, *viz.*,

(*a*) Institutions catering for post-graduate education and research.

(*b*) Institutions catering for higher education in engineering and technology upto degree standard or its equivalent.

(*c*) Institutions catering for education and training upto the diploma or licentiate standard.

The following statement shows zone-wise the courses of study offered in each institution, the latest admissions into each course, average annual outturn of personnel in 1941-46 and outturn in 1946-47. A note also is added on the staff and physical facilities available in the institutions mentioned.

STATEMENT I

Southern Zone—

(A) *Institutions providing facilities for Post-graduate training and Research.*

Institution	Subjects	Latest intake	1941-46 average annual outturn in 1946-47	Remarks
(1)	(2)	(3)	(4)	(5)
1 Indian Institute of Science, Bangalore	Internal Combustion Engg.	8	..	Courses in Internal Combustion Engineering, Metallurgy and Power Engineering are under organization and the necessary physical facilities are being created.
	Metallurgy	12	..	
	Aeronautical Engineering	4	4	
2 College of Science, Andhra University, Waltair	Applied Physics	8	8	Equipment and accommodation are adequate for teaching but inadequate for research. Staff needs strengthening in the lectures category.
	Chemistry of Foods and Drugs	6	6	
	Chemical Technology	2	2	

(1)	(2)	(3)	(4)	(5)
	(B) Institutions providing facilities for training upto the Degree standard.			
1 College of Engineering, Guindy, Madras	Civil Engineering Highway Engineering Mechanical Engineering Electrical Engineering Tele-communication Engineering	40 20 20—30 20—30 12—20 B.E. degree	40 20 25 25 10	Equipment adequate; buildings unsatisfactory. Staff inadequate.
2 College of Engineering, Bangalore	Civil Engineering Mechanical Engineering Electrical Engineering Chemical Engineering	125 B E. degree	40 30 20	Equipment and buildings just adequate but the condition of the former is not satisfactory. Purchase of new appliances and equipments is necessary. Staff inadequate.
3 Arthur Hope College of Technology, Coimbatore	Civil Engineering Electrical Engineering Automobile Engineering Textile Technology	75 B.E. degree		The institution is in the formative stage and courses only in civil and electrical engineering have been organised. Provision exists for 30 in civil engineering and for 30 in electrical engineering. Equipment good ; buildings adequate ; staff adequate for the present. The first batch is in 3rd year class. Automobile engineering will start early next year.
4 College of Engineering, Travancore	Civil Engineering Mechanical Engineering Electrical Engineering Chemical Engineering	34 8 8 B.Sc. in Engg. Post-graduate diploma course which is under reorganisation for degree in chemical engineering.	10 5 5	Equipment inadequate ; buildings unsatisfactory ; staff inadequate.
5 College of Engineering Cocanada	Civil Engineering Electrical Engineering Mechanical Engineering Naval Architecture and Marine Engineering	105 B.E. Eng.		The institution was started only last year and hence is in a formative stage. It has been specially meant for naval architecture and marine engineering subjects. If due to any difficulty these subjects are not organised in time, the institution will develope for the rest of the branches of engineering. Staff, equipment and accommodation etc. are yet to be properly provided.
6 College of Engineering Anantapur	Civil Engineering Electrical Engineering Mechanical Engineering	50 B.E. Engg.		The institution was started only last year and is in a formative stage.
7 College of Engineering and Technology, Annamalai University	Civil Engineering Mechanical Engineering Electrical Engineering Chemical Engineering	60 20 20 25 B.E. Engg.	The College was started only three years back and the 1st batch is in the third year classes	Position in respect of staff, equipment and accommodation is most unsatisfactory.
8 Alagappa Chettiar College of Technology, University of Madras	Chemical Engineering Leather Technology Textile Technology	20 20 20 B.Sc. Tech.	20 5 5	College is under organisation. Equipment not bad ; accommodation very bad ; staff inadequate.

(1)	(2)	(3)	(4)	(5)
9 Sri Krishnarajendra Silver Jubilee Technological Institute, Bangalore	Textile Technology	25-B.Sc. Tech.	The course started only in 1946-47	Equipment adequate ; accommodation satisfactory ; staff inadequate.
10 Indian Institute of Science Bangalore	Communication Engineering Aeronautical Engineering Electrical Technology	15 12 30	15 12 30	Courses in Power Engineering Internal Combustion Engineering and metallurgy are under organisation and necessary equipment are being procured and buildings are under construction. For the rest of the courses, staff equipment and buildings are adequate.
11 College of Science and Technology, Andhra University	Applied Physics Applied Chemistry	12 12	10 10	Equipment is adequate for teaching but inadequate for research. Accommodation is adequate. Staff is adequate although it needs to be increased in the lecturers category.

(C) *Institutions providing facilities for training upto the Diploma or Licentiate standard.*

(1)	(2)	(3)	(4)	(5)
1 College of Engineering, Guindy, Madras	Civil Engineering	90	90	Ref. to (A) 1 above.
2 Engineering School, Bangalore	Civil Engineering Mechanical Engineering Electribal Engineering	Details are not furnished. Intake and outhern may be taken the same as in the degree courses.		Ref. to (B) 2 above.
3 College of Engineering, Trivandrum	Civil Engineering Mechanical Engineering Electrical Engineering	34 8 8	10 5 5	Ref. to (A) 4 above.
4 Institute of Leather Technology, Govt. of Madras	Leather Technology	12	10—12	Equipment adequate ; accommodation very unsatisfactory ; staff adequate.
5 Institute of Textile Technology, Govt. of Travancore	Weaving Spinning Dyeing, Bleaching and Printing	6 6 12	6 6 12	Equipment unsatisfactory ; accommodation inadequate ; no details regardingstaff.
6 Sri Krishnarajendra Silver Jubilee Technological Institute, Bangalore	Textile Technology	15	10	Ref. to (A) 9 above.
7 Sri Jayachamarajendra Occupational Institute, Bangalore	Mech. Engg., Elect. Engg., Civil Engg., Mining, Ceramics, Glass, Radio, Cinematography and Sound Engg. Printing, Automobile Engineering	400	250	The institution is both a polytechnic and an occupational institute, meant for diploma and artisan standards of training. A very well organised institution and the existing facilities by way of staff, equipment and accommodation are adequate
8 Maharaja's Technological Institute, Trichur	Civil Engineering Mechnical Engineering Electrical Engineering	30 35 35	.. .. ..	The institute was started in 1947 and is in a formative stage. Facilities by way of staff, equipment and accommodation are poor.
9 Polytechnic of Govt. of Madras in Madras	Civil Engineering Mechanical Engineering Electrical Engineering Sanitary Engineering Printing Technology Fisheries Navigation Cinematography Sound Engineering	20 20 20 20 20 20 20 20 20	.. ..	All these seven polytechnics have just been started and the institutions are still under development, and hence the facilities are not adequate at present. Just the minimum of equipment and staff for starting the courses have been provided. The present position is, therefore, fluid and nothing can be said about the facilities available until the institutions take shape.

(1)	(2)	(3)	(4)	(5)
Polytechnic of Government of Madrs in Mangalore	Civil Engineering	20		
	Mechanical Engineering	20		
	Automobile Engineering			
Do. Calicut	Mechanical Engineering	20		
	Electrical Engineering	20		
	Chemical Engineering	20		
	Food Technology	20		
Do. Madura	Civil Engineering	20		
	Mechanical Engineering	20		
	Electrical Engineering	20		
	Automobile Engineering	20		
Do. Coimbatore	Automobile Engineering	20		
	Radio Engineering	20		
Do. Vuyyur	Civil Engineering	20		
	Mechanical Engineering	20		
Do. Cocoanada	Civil Engineering	20		
	Mechanical Engineering	20		
	Electrical Engineering	20		
	Technical Engineering	20	and Navigation 20	
10 Kerala Soap Institute, Calicut	Soap and Oil Technology	12	12	Factory training facilities and staff are adequate. Accommodation not satisfactory. The institute also provides three months' short term course in soap and oil technology for B.Sc. graduates in chemistry.
11 Maharaja's College Ernakulam	Technology of soaps* oils and fats	6	6	Equipment and accommodation adequate ; staff needs strengthening.
	Pharmaceuticals* and drugs	6	6	

* The above courses relate to Post-graduate Diploma for B. Sc. graduates.

Eastern Zone.—

(A) *Institutions providing facilities for Post-graduate or its equivalent training and research.*

(1)	(2)	(3)	(4)	(5)
1 Department of Applied Physics, Calcutta University	Applied Physics	28	18	
2 Department of Applied Chemistry, Calcutta University	Applied Chemistry	38	19	
3 College of Engg. and Technology, Jadavpur	Chemical Engineering	1		
	Physical Chemistry	1		
	Organic Chemistry	2		
	Refrigeration	2		
	Electrical Engineering			
	Mechanical Engineering			
4 Bengal Engineering College, Sibpur, Howrah	Civil Engineering	Post-graduate degree or diploma		
	Mechanical Engineering			
	Electrical Engineering			
	Metallurgical Engineering			
5 Eastern Higher Technical Institution (To be constructed at Kharagpur, B.N. Rly.)	Fuel Technology, Pharmaceuticals and Fine Chemicals, Regional Planning, Paper technology, Glass and Ceramics, Plastics, Paints and Pigments, Hydraulics and River Research, Transportation (including Rly. Engg.), Structural Engg. (including High Dams), Design of elect. machinery, Refrigeration and air-conditioning, Automobile Engineering, Machine tools, Design of Machinery and instruments, Light alloys, Industrial Physics, Electronics, Economic Botany, Geophysics, Geology Minerology, Meteorology, Food Technology	Post-graduate degree and diploma		The institution is in the process of establishment. It is proposed to provide facilities for training of about 660 post-graduate students and research workers in the institution, when in full swing.

(1)	(2)	(3)	(4)	(5)
Eastern Zone				
	(B) *Institutions providing facilities for training upto the degree or equivalent standard*			
1 Bengal Engineering College, Sibpur, Howrah	Civil Engineering	104	36	
	Mechanical Engineering	26	10	
	Electrical Engineering	29	8	
	Metallurgical Engineering	6	13	
	Architecture	..	..	
2 College of Engineering and Technology, Jadavpur	Electrical Engineering } Mechanical Engineering }	356	42	
	Chemical Engineering	80	17	
	Civil Engineering	..	..	These courses are proposed to be started.
	Textile Engineering	..	..	
	Geological Engineering	..	..	
	Agriculture	..	..	
	Building and Architechtural Engg.	..	..	
	Military Engineering	..	..	
	Aeronautical Engineering	..	..	
3 Calcutta Engineering College, Ballygunge, Calcutta	Civil Engineering	10	Started 1946	The institution started only in 1946
4 Bengal Textile Institute, Berhampore	Textile Technology (Proposed course)			These courses are porposed to be started.
5 Bengal Silk Technical Institute, Berhampore	Silk Technology			
	Wool Technology			
	Artificial Synthetic-Fibre Technology			
6 Sericultural Training Institute. (A training college in sericulture to be established)				
7 Bihar College of Engineering Patna	Civil Engineering	50 16	25 Recently started	
8 Sindri Engineering College, Sindri (Proposed)	Electrical Engineering } Mechanical Engineering }			The institution is proposed to be established by the incorporation of the Bihar College, Engineering, Patna.
9 Eastern Higher Technical Institution (Kharagpur)	Aeronautical Engineering	60		The institution is in the process of establishment and the figure indicate the number to be admitted into each course.
	Civil and Sanitary Engineering	60		
	Chemical Engineering	90		
	Electrical Engineering	90		
	Mechanical Engineering	90		
	Building Construction	90		
	Metallurgy	30		
	Meteorology	15		
10 Indian School of Mines, Dhanbad	Mining	24	20	

(1)	(2)	(3)	(4)	(5)
Eastern Zone—contd.				
(C) *Institutions providing facilities for training upto the Diploma or Licentiate standard*				
1 College of Engineering and Technology, Jadavpur	Electrical and Mech. Engg. (Combined)	75	23	
	Civil Engineering . . .	60	7	
	Agriculture	10	2	
	Automobile Engineering .	50	49	
2 Calcutta Engineering College, Ballygunge	Civil Engineering . . .	90	22	
	Mech. and Elect. Engineering .	300	18 (The intake this year has been increased by 260)	
3 Calcutta Technical School, Calcutta	Mech. and Elect. Engg. . .	103	53	
	Sanitary and Plumbing Engg. .	2	1	
	Electrical Supervisor . .	38	6	
	Welding (Electric and Gas) .			
	Printing			These courses are proposed to be started with an intake of 10 students into each course.
	Textile Machinery . . .			
	Paper Technology . . .			
	Automobile Engineering . .			
	Marine Engg. and Naval Architecture			
	Draughtsmanship . . .			
	Ceramics			
	Soap Technology . . .			
	Plastics			
4 Kanchrapara Technical School, Kanchrapara	Mech. and Elect. Rly. Apprenticeship	16	12	
5 B.N.R. Technical Institute, Calcutta	Mech. and Elect. Rly. Apprenticeship	25	20	
6 Bengal Tanning Institute, Calcutta	Leather Technology			
	(*i*) Tanning . . .	15	7	
	(*ii*) Boot, Shoe and Leather Goods Manufacture	14	7	
	(*iii*) Microscopy and Bacteriology of leather, Leather Trades Engg., Book-keeping and Cost Accountancy.	2	1	
7 Bihar College of Engg., Patna	Civil Engineering (Subordinate)	60	29	
	Industrial Diploma . .	16	10	
8 The Jamshedpur Technical Institute, Jamshedpur	(*i*) Mechanical Engg. . .	Not known		
	Electrical Engg. . .			
	Metallurgy . . .			
	(*ii*) Trade Apprenticeship .			
9 E. I. Technical Institute, Jamalpur	Mech. and Elect. Rly. Apprenticeship	30	25	
10 Orissa School of Engg. Cuttack, Orissa	Civil Engineering . . .	107	34	
	Elect. and Mech. Engg. . . .	Proposed to be started.		
11 Balasore Technical School, Balasore, Orissa	Wood work	10	2	
	Metal work			
	Machine shop . . .			
	Motor Car Fitting . .			
	Electric wiring . . .			
12 Bengal Textile Institute, Serampore	Textile Technology . .	54	24	
13 Bengal Silk Technological Institute, Behrampore	Silk Technology . . .	19	15	

(1)	(2)	(3)	(4)	(5)
***Western Zone*—contd.**				
(A) *Institutions providing facilities for Post-graduate training and research*				
1 Department of Chemical Technology, University of Bombay	Research in Chemistry and Chemical Technology	51 Research workers	6M.Sc. (Tech.) 3 Ph.D. (Tech.)	
2 Lakshminarayan Institute of Technology, Nagpur	Research in Chemical Technology	10 Research Workers		
3 Western Higher Technical Institute	Pharmaceuticals and Fine chemicals, Cellulose Technology, Plastics, Paints and Pigments, Dye Chemistry, Food technology, Transporation Engineering, Structural Engineering including high dams, Design of Electrical Machinery, Refrigeration and Air-conditioning, Design of Machinery and Instruments. Textile technology, Textile Engg., Textile Chemistry, Light Alloys, Naval Architecture and Marine Engineering, Economic Botany, Hydraulic and River Research, Regional Planning.			The institution is in the course of establishment. It has been envisaegd that provision will be made for about 1000 students at a time in all the subjects when the institution is in full swing.
(B) *Institution providing facilities for training upto the Degree standard*				
1 Government Engineering College, Jubbulpore	Civil Engineering	30	College started only in 1947-48	The institution was started only this year. The first batch of students is expected to be turned out in 1951-52 and is likely to compromise in civil engineering, 14 in electrical engineering and 11 in communication engineering. Only two batches will pass out during the next 5 years.
	Mechanical Engineering	15		
	Electrical Engineering	20		
	Communication Engineering	15		
2 College of Engineering, Poona	Civil Engineering	100	52	The courses are under reorganisation. Separate courses in electrical and mechanical engg. will be abolished and instead combined courses in both these branches will be instituted.
	Mech. & Elect. Engg. (combined)	50	12	
	Mech. Engineering	..	18	
	Electrical Engineering	..	20	
	Telecommunication Engg.	20	To be started this year	
	Metallurgy	10	To be started this year.	The metallurgy course is expected to commence in 1948.
3 Department of Chemical Technology, Bombay University	Textile Chemistry	16	14	All the courses leading upto B.Sc. (Tech.) are post-graduate courses in the sense that the minimum admission qualifications are a degree in chemistry.
	Chemical Engineering	16	14	
	Intermediate and Dyes	12	8	
	Plastics, Paints and Varnishes	6	4	
	Oil, Fats and Soaps	8	5	
	Pharmaceuticals and Fine Chemicals	12	5	
	Foods and Drugs	10	4	
4 Lakshminarayan Institute of Technology, Nagpur University	Chemical Technology including Chemical Engineering	—	13	It appears that the courses are under re-organisation. At present the courses are of two years' duration after the B. Sc. stage. Separate courses in Chemical Engineering and Oil. Technology have been started.
	Chemical Engineering	12	—	
	Oil Technology	12	—	

(1)	(2)	(3)	(4)	(5)
Western Zone—contd.				
5 The New Engineering College, Sangli	Civil Engineering	60	..	The institution started only in 1947.
6 V.J.T. Institute, Bombay	Textile Technology	14	First batch will come out only in 1950,	Courses in textile technology started in June 1946 and the first batch of students will come out only in 1950. Courses in Mechanical and Elect. Engg. started in June 1947 and the first batch will come out only in 1951
	Mechanical & Electrical Engg. (Combined)	54	First batch will come out only in 1951.	
7 Western Higher Technical Institution	Building Construction and Architecture	90	..	The institution is in the course of establishment. The numbers noted in the intake column are those that shave been proposed.
	Chemical Engineering	90	..	
	Civil and Sanitary Engg.	60	..	
	Electrical Engineering	90	..	
	Geology and Geophysics	30	..	
	Mechanical Engineering	90	..	
	Textile Technology	90	..	
	Metallurgical Engineering	30	..	
	Naval Architecture and Marine Engineering	90	..	

(C) *Institutions providing facilities for training upto the Diploma or Licentiate standard*

(1)	(2)	(3)	(4)	(5)
1 Government Engineering School, Nagpur	Civil Engineering	34	13	
	Mechanical Engineering	15	12	
	Automobile Engineering	16	..	
	Electrical Engineering	39	..	
	Architecture	8	..	
2 V.J.T. Institute, Bombay	Mechanical Engineering	60	39	
	Electrical Engineering	60	40	
	Textile Engineering	40	23	
	Technical and Applied Chemistry	20	24	
	Sanitary Engineering	10	7	
3 Kalabhavan Technical Institute, Baroda	Mechanical Engineering	25	17	
	Electrical Engineering	25	14	
	Civil Engineering	30	12	
	Architecture	20	3	
	Chemical Technology	25	20	
	Weaving Technology	20	12	
4 College of Engineering, Poona	Civil Engineering	100	55	
	Mechanical and Elect. Engg.	50	19	
5 R. C. Technical Institute, Ahmedabad	Civil Engineering			Diploma courses in the various subjects started only in 1947 and it is expected that the outturn will be 50 in combined Mech. and Elect. Engineering, 50 in Civil Engineering, 30 in Textile Technology and 10 in Textile Chemistry and Finishing during the next 5 years.
	Mechanical and Elect. Engg.			
	Textile Technology			
	Textile Chemistry & Finishing			
6 Sir Cursow Wadia Institute of Electrical Technology, Poona.	Electrical Engineeing	45	19	

(1)	(2)	(3)	(4)	(5)
Northern Zone—				
	(A) *Institutions providing facilities for Post-graduate training and Research*			
1. College of Technology Benares Hindu University.	Research and instruction in Industrial Chemistry.	20 (M.Sc.)	16 (M.Sc.)	Equipment moderate, Staff inadequate.
	Ceramics	..	2 (M.Sc.)	
	Glass Technology	..	..	
	Pharmaceutics.	1 (M.Sc.)	3 (M.Sc.)	
2. Harcout Butler Technological Institute, Kanpur	General applied chemistry and Chemical Technology	1	..	
	Oil Chemistry & Oil technology	2	..	
3. Indian Institute of Sugar Technology, Kanpur	Sugar tchnology	2	..	The courses of study in the institution are undergoing some reorganisation.
	Sugar Engineering	..	..	
	(B) *Institution providing facilities for training upto the Degree standard*			
1 Engineering College, Benares Hindu University	Electrical and Mechanical Engg.	137	127	Equipment adequate ; staff inadequate ; accommodation satisfactory. It is proposed to start separate courses in civil-electrical and mechanical engineering.
2 College of Technology, Beneres Hindu University	Industrial Chemistry	70	54	Equipment moderate ; Staff inadequate.
	Coamics	14	16	
	Glass Technology	15	10	
	Pharmaceutical Chemistry	16	17	
3 College of Mining and Metallurgy, Benares Hindu University	Mining-	20*	6	Staff inadequate.
	Metallurgy	40*	27	*The admissions indicated are those expected to be made from 1949 onwards. The latest admi, ssions are, however, slightloy less ; but full details are not available.
4 College of Engineering Muslim University, Aligarh	Civil Engineering	39	46	Existing facilities by way of staff accommodation and equipment are adequate.
	Mechanical Engineering	20	21	
	Electrical Engineering	23	16	
5 Engineering College, Roorkee	Civil Engineering	30	..	Degree courses in the institution were started only in 1947
	Mechanical Engineering	15	..	
	Electrical Engineering	13	..	
6 Birla Engineering College, Pilani	Electrical Engineering and Mechanical Engineering (combined)	150	..	The institution started only in 1946 and the first batch of students—78 is in the 2nd year class.
7 East Punjab Engineering College, Roorkee	Civil Engineering	18	19	
	Mechanical Engineering	9	7	
	Electrical Engineering	9	4	
8 Delhi Polytechnic, Delhi	Electrical Engineering } All India Diploma of Degree standard	51	27	Equipment satisfactory ; Accommodation inadequate ; staff adequate.
	Chemical Technology	16	5	
	Architecture	12	8	
9 Harcout Butler Technological Institute, Kanpur	General Applied and Chemical Technology	4	2	
	Oil Chemistry and Oil Technology	21	22	
10 Indian Institute of Sugar Technology, Kanpur	Sugar Technology	15	13	The courses of study in the institution are undergoing reorganization.
	Sugar Engineering	..	..	

Northern Zone—contd.

(1)	(2)	(3)	(4)	(5)
	(C) *Institution providing facilities for training upto the Diploma or Licentiate standard*			
1 College of Engineering, Muslim University, Aligarh	Civil Engineering . . .	8	14	
	Mechanical Engineering . .	5	6	
	Electrical Engineering . .	9	9	
2 Thomason College of Engineering, Roorkee	Civil Engineering . . .	80	74	
3 Harcout Butler Technological Institute	Oil Technology . .	} ..	16	
	Chemical Technology .			
4 Indian Institute of Sugar Technology	Sugar Engineering (Certificate Course)	2	3	Excepting Sugar Engineering, the rest of the courses appear to be short-term courses for specific operational duties in Sugar Industry.
	Chemical Control	10	6	
	Bacteriology	..	3	
	Pan Boiling	5	6	
	Fuel and Boiler Control . .	1	1	
	Milling Plant Operation and Control	2	1	
	Statistical Methods . . .	..	1	
5 Government Technical Institute, Lucknow	Electrical and Mechanical Engg. (Combined)	31	26	
6 Government Technical Institute, Gorakhpur	Electrical and Mechanical Engg. (Combined)	33	29	
7 Punjab Institute of Textile Technology, Amritsar	Textile Technology . .	20	17	
8 Government Central Textile Institute, Kanpur	Textile Technology . .	17	15	
	Textile Chemistry and Textile Finishing	13	13	
9 Government Technical Institute, Jhansi	Electrical and Mechanical Engineering (combined)	23	11	
10 Government Metal Works Institute, Ambala City	Mechanical Engineering . .	25	13	
11 Technical College, Jodhpur .	Mechanical Engineering . .	10	5	
12 Civil Engineering, School Lucknow	Civil Engineering . . .	90	5	
13 Delhi Polytechnic, Delhi .	Electrical Engineering . .	33	6	
	Textile Technology . .	13	6	
	Architecture	12	8	
14 Technical Collge, Dayalbagh	Electrical and Mechanical Engg. (combined)	25	23	
15 Benares Hindu University.	Soap Technology	16	14	

Southern Zone

4. From the above analysis it will be observed that in the Southern Zone facilities for post-graduate training and research in engineering and technology facilities have been developed to a small extent only and are confined to only two institutions—the Indian Institute of Science and the College of Science and Technology, Andhra University. The subjects covered are also few, *viz.* Internal Combustion Engineering, Metallurgy, Power Engineering, Aeronautical Engineering, Applied Physics and Chemical Technology. The first four subjects are taught in the Indian Institute of Science and the other two in the Andhra University. Aeronautical Engineering is a well-established course at the Institute and every year 4 students are admitted for post-graduate training and research. The Departments of Internal Combustion Engineering, Power Engineering and Metallurgy at the Institute have just been started and the departments are still in a formative stage. Chemistry of Foods and Drugs forms a special feature of the Chemical Technology course at the Andhra University in the post-graduate stage.

5. In the matter of engineering education upto the degree or its equivalent standard, Southern Zone has shown great progress. Every one of the ten engineering institutions in the zone provides courses in all the three main branches of engineering—civil, electrical and mechanical. The Engineering College, Guindy offers specialised courses in Communication Engineering and in Highway Engineering. Chemical Engineering upto the degree standard is offered at the Alagappa Chettiar College of Technology. In the College of Engineering, Bangalore is also proposed to provide in the near future a degree course in Chemical Engineering. Engineering College, Trivandrum also offers a diploma course in Chemical Engineering for B. Sc. graduates. This course is shortly to be abolished and instead a degree course in Chemical Engineering organised. A degree course in Naval Architecture and Marine Engineering is intended to be provided for in the new Engineering College at Cocoanada. The Indian Institute of Science has arranged for courses of fairly advanced standards in internal combustion engineering and metallurgy and has already admitted the first batch of students into these courses. But it will be sometime before these new departments are properly organised, as the necessary buildings are still under construction and most of the equipment are yet to be obtained. Aeronautical engineering, Electrical technology and Electrical Communication engineering are the three important subjects in which the Institute has already organised advanced training and turned out several batches of trained personnel. At present, the Indian Institute of Science is the only institution in the country where aeronautics is taught. It is also the only institution in the country offering advanced training in Communication Engineering barring perhaps the Guindy Engineering College. It is, however, to be noted here that the Indian Institute of Science is an all-India institution and caters to the needs of the whole country.

6. There are only three institutions of technology—the Alagappa Chettiar College of Technology, the Silver Jubbilee Technological Institute and the College of Science and Technology, Andhra University which offer training upto the degree standard in certain technological subjects. The Alagappa Chettiar College of Technology which has been started recently offers courses in Leather Technology and Textile Technology, while the Silver Jubilee Technological Institute at Bangalore only Textile Technology and the College of Science, Andhra University, have arranged for courses in Textile Technology and in Chemical Technology and Applied Physics upto the B. Sc. (Hons.) Standard. The Textile Technology course in the Silver Jubilee Technological Institute has been starred only recently. It is thus seen that both in the number of institutions and in the range of subjects covered, the present position indicates somewhat limited development. No institution has so far organized advanced courses in the various branches of chemical technology, glass and ceramics, fermentation technology, paper and cellulose technology and many other technological subjects, which are of importance in the context of the industrial development of the country. There is, therefore, need for organising such courses in the existing institutions or in new ones, started for the purpose.

7. It has to be mentioned here that little or no research either in engineering or in technology is being carried out at present in any of the institutions, excepting perhaps at the Indian Institute of Science, Bangalore. The reasons are not far too seek. The institutions have been developed only for teaching and in many of them, the available facilities are not adequate even for this purpose.

8. The Southern Zone has 16 institutions providing junior courses in engineering and technology leading to diploma or equivalent certificate. These include seven new Polytechnics, recently started by the Government of Madras at various centres in the province. Provision has been made in these

for a wide range of engineering and technological subjects, *viz.* all branches of engineering, Fisheries technology, Navigation, sound Engineering and Cinematography, Food technology, Printing technology etc. The Jayachamamajendra Occupational Institute in Bangalore is one of the best organised institutions of this type in the country and covers a wide range of subjects in engineering and technology, and offers training both upto the diploma and the artisan standards. We have in the section on 'Industries' referred to the Kerala Soap Institute, Calicut, which combines in one both a manufactory and a technological institution. The Maharaja's College, Ernakulam, offers Post-B. Sc. diploma courses in Soaps, Oils and Fats and in Pharmaceuticals and Fine Chemicals. The details of the various courses of study provided for in each institution, the intake and outturn into each course are given in statement I.

Eastern Zone

9. In the Eastern Zone facilities for post-graduate education and research exist only on a limited scale and are provided at present in two institutions. These are the Post-graduate Departments of the Calcutta University which offer advanced training and research in Applied Physics and Applied Chemistry. However on the recommendations of the Sarkar Committee, a Higher Technical Institution of an all-India character is shortly to be established in this zone for post-graduate education and research in the various branches of engineering and technology. It has been decided to provide at this institution, facilities for 650 post-graduate research workers in such subjects as fuel technology, pharmaceuticals and fine chemicals, glass technology, ceramics, plastics, regional planning, paper technology, hydraulics and river research, transportation engineerng, structural engineering, construction of high dams, design of electrical machinery, refrigeration and air-condition, automobile engineering, machine tools, design of machinery and instruments, light metal alloys, industrial physics, electronics, geophysics, geology and minerology and food technology. Since the institution is yet in the process of being established, several years will Perhaps elapse before the first batch of students pass out of the institution.

10. The development of engineering and technological education upto the graduate standard has also not been commensurate with the industrial importance of this zone. There are only three engineering colleges of which only one, *viz* Bengal Engineering College is offering courses in all the three main branches civil, mechanical and electrical. Metallurgical engineering also is taught in this institution. Of the other two colleges, the Jadavpur College of Engineering offers mechanical, electrical and chemical engineering and the Bihar College of Engineering, civil engineering and electrical engineering, the latter subject only from this year. The present output is 61,77 and 50 respectively in civil, mechanical and electrical engineering. A new college—the Calcutta College of Engineering, Ballygunge—has just been started with an intake of 10 students in civil engineering. There is also a college at Sindri for electrical and mechanical engineering. In the matter of technological education upto the degree standard, there is as yet no institution which provides for any of the technological subjects.

11. The Eastern Higher Technical Institution when fully established will provide for the training of about 570 students upto the degree standard in such subjects as aeronautical engineering, civil and sanitary engineering, chemical engineering, electrical engineering, mechanical engineering, building engineering metallurgy, geology and geophysics and meteorology. But the establishment of the institution itself is a long-range project and it is not likely that the first batch of students will come out during the next 5 years.

12. Special mention must be made here of the Indian School of Mines, Dhanbad which provide training in Mining and Applied Geology upto the B. Sc. and M. Sc. standards. The present outturn is 20 students/year. On the recommendations of the Indian School of Mines Reorganisation Committee, the institution is being reorganised.

13. In the matter of facilities for technical education upto the diploma or licentiate standard also, the development in this zone has been poor. There are only 10 institutions offering courses in civil electrical and automobile engineering with an aggregate outturn of 93,6 and 49 respectively. Excepting leather technology, no other technological subject is provided for in any of the institutions. Leather technology is offered in the Bengal Tanning Institute, which conducts separate courses in tanning leather goods manufacture and microscopy and bacteriology of leather.

Western Zone

14. In the Western Zone, there are no facilities for post-graduate training and research in engineering subjects. In technology, the Department of Chemical Technology, Bombay, provides facilities for about 50 research workers in the various branches of applied chemistry--textile chemistry, intermediates and dyes, plastics, paints and varnishes, soaps, oils and fats, and pharmaceuticals and fine chemicals. The institution also trains about 6 students in chemical technology upto M. Sc. (Tech.) standard. The Lakshminarayan Institute of Technology, Nagpur University has facilities for about 10 research workers in General Chemical Technology. The Western Higher Technical Institution proposed to be established in this zone would provide facilities for about 1000 post-graduate students and research workers in a wide range of engineering and technological subjects comprising pharmaceuticals and fine chemicals, cellulose technology, plastics, paints and pigments, dye chemistry, food technology, transportation engineering, structural engineering, refrigeration and air-conditioning, design of machinery and instruments, textile technology, textile engineering, textile chemistry, light metal alloys, navalarchitecture and marine engineering and hydraulics and river research. The estalishment of the institution is, however, a long-range project, likely to take several years for completion.

15. Compared to other zones, progress in engineering education upto the degree standard has been less in the Western Zone. Of the four engineering colleges now functioning, three were started only this year. The fourth—the college of Engineering, Poona—is an old established institution and offers civil, mechanical and electrical engineering course separately as well as a combined course in mechanical and electrical engineering. Separate courses in mechanical and electrical engineering are, however, to be abolished and only training in the combined course is to be offered. The institution has also this year started courses in tele-communication engineering and metallurgy. Of the three new institutions, one will offer civil engineering, mechanical engineering, electrical engineering, and communication engineering courses separately ; the other only civil engineering and the third combined mechanical and electrical engineering. It is to be noted that the trend of development is towards starting combined courses in electrical and mechanical engineering. Chemical engineering has been provided for in the Department of Chemical Technology, Bombay University and in the Lakshminarayan Institute of Technology, Nagpur from this year.

16. In the matter of technological education, development in The Western Zone has been fair. The various important branches of chemical technology—textile chemistry, intermediate and dyes' plastics, paints and varishes, oils, fats and soaps, pharmaceuticals and fine chemicals, foods and drugs—are offered in the Department of Chemical Technology, Bombay University. General chemical technology is also offered in the Lakshminarayan Institute of Technology, Nagpur. But this course is being reorganised now with a view to starting separate courses in chemical engineering and in the technology of soaps, oils and fats. Course in Textile technology upto the degree standards has been started in V. J. T. Institute, Bombay from this year.

17. Apart from providing post-graduate training and research facilities, the proposed Western Higher Technical Institute will offer courses upto degree standard in all the basic engineering subjects —textile technology, naval architecture and marine engineering, metallurgical engineering and chemical engineer.ng. It has been proposed to train 640 students every year in all the subjects when the institution is fully established.

18. As regards lower technical education also, the present state of development in the zone is far from satisfactory. Only 4 institutions are at present functioning, the range of subjects covered included civil, mechanical, electrical and automobile engineering, chemical technology, textile technology and textile engineering. A new institution with provision for all the three basic branches of engineering textile chem.stry and textile technology has been started this year in Ahmedabad.

Northern Zone

19. Facilities for post-graduate education and research in engineering are practically nil in the Northern Zone. But technological education, especially in industrial chemistry, glass technology, ceramics, pharmaceuticals and oil technology has developed to a considerable extent. Benares Hindu University offers post-graduate training in all these subjects and the Harcourt Butler Technologica

Institute offers advanced training in oil technology. The Indian Institute of Sugar Technology situated in this zone is the only institution in the country which offers advanced training in sugar technology and sugar engineering.

20. There are six institutions in this zone offering engineering education upto the degree standard. Of these, two have been started only recently. Civil engineering is taught in three institutions. Separate courses in electrical and mechanical engineering are provided in four institutions while in the other two, combined courses are offered. Chemical engineering is offered only in one institution, namely, the Delhi Polytechnic.

21. Technological subjects are at present offered in four institutions in this zone. Of these, the Indian Institute of Sugar Technology specialises in sugar technology and sugar engineering and the Harcourt Butler Technological Institute in oil technology. The latter also offers chemical technology. Industrial chemistry, ceramics, glass technology and pharmaceutics are the technological courses offered at the Benares Hindu University. Degree courses in mining and metallurgy are offered in the College of Mining and Metallurgy of this University. The intake and outturn of students for the various engineering and technological courses are given in statement I institutionwise.

22. In the matter of junior technical education the position in this zone is not quite satisfactory although there are at present 16 institutions. The range of subjects is limited and in some institutions only one or two subjects are taught. All the three main branches of engineering—civil, mechanical and electrical—are offered in only one institution, while in others either electrical or mechanical engineering course is offered. Four intitutions offer combined courses in mechanical and electrical engineering. Of the technological subjects only soap and oil technology and textile technology are provided for in the institutions. It is, however, to be noted that the Indian Institute of Sugar Technology offers a certificate course in sugar engineering as well as short-term courses for specific operational duties in sugar industry.

23. It is to be noted here that all the engineering and technological institutions in the country suffer from such handicaps as lack of equipment or lack of adequate staff or lack of adequate accommodation or all the three. This is chiefly due to two factors, *viz.*, increase in the intake of students in the case of well-established institutions which, however, have not been able to expand their facilities correspondingly, and secondly in the case of institutions which have been started recently, the schemes of development have been inadequately given effect to mainly for lack of funds. The available facilities in respect of equipment, staff, teaching accommodation etc., in many of these institutions hardly fulfil 40% of the minimum requirements as suggested by the A.I.C.T.E. This unsatisfactory state of affairs is having an adverse effect on the standard of education in the institutions. The first approach to the problem of development of engineering and technological education should, therefore, be to strengthen the existing facilities in the institutions so as to meet adequately the requirements for the present intake of students and to bring up the training to the desired level.

24. It has to be mentioned here that little or no research either in engineering or in technology is being carried out at present in any of the institutions, excepting perhaps at the Indian Institute of Science, Bangalore. The reasons are not far too seek. The institutions have been developed only for teaching and in many of them, the available facilities are not adequate even for this purpose. The academic atmosphere prevailing in the institutions is anything but conducive to research. The staff of almost all the institutions are heavily burdened with teaching work and are left with little time for research. The equipment and other facilities available for research are very poor and there is little collaboration and contact between the Industry and the institutions. Besides, there are no research scholarships or fellowships worth mentioning in any of the institutions. Unless these existing handicaps are removed no real impetus can be given to engineering and industrial research. Members of staff should get sufficient time for research and at the same time, research scholarships or fellowships should be instituted in each institution. The existing physical facilities, by way of equipment, accommodation etc. should be improved not only for teaching but also for research. And there should be close liaison between Industry and the educational institutions, so that the latter might cater to the needs of the Industry both in the matter of research and in the training of personnel.

25. On the basis of the average annual outturn during 1941-46 or on the basis of the outturn during 1946-47 of post-graduates, graduates and diploma holders or their respective equivalents from each institutions in all the four zones, the following statement has been prepared to indicate the present outturn of personnel of various categories, shown zonewise.

STATEMENT III

Present outturn of personnel per year shown zone-wise

(a), (b) and (c) indicate respectively post-graduates and research workers, graduates and diploma holders or their respective equivalents.

Subjects	Southern Zone (a)	Southern Zone (b)	Southern Zone (c)	Western Zone (a)	Western Zone (b)	Western Zone (c)	Eastern Zone (a)	Eastern Zone (b)	Eastern Zone (c)	Northern Zone (a)	Northern Zone (b)	Northern Zone (c)	Total (a)	Total (b)	Total (c)
Civil Engg.	..	90	155	..	52	80	..	61	93	..	65	114	..	268	442
Mech. Engg.	..	60	50	..	18	68	..	77	..	..	28	24	..	183	142
Elect. Engg.	..	80	445	..	20	73	..	50	6	..	47	15	..	197	139
Mechanical and Electrical Engg. (Combined Course)	..	..	..	..	12	19	..	..	163	..	127	89	..	139	271
Tele-communication Engineering	..	25	20	..		..	..	..	..	..	..	..	..	25	20
Highway Engg.	..	20	12	..	..	..	..	..	..	..	..	..	..	20	..
Mining	..	..	12	..	..	..	..	20	..	..	6	..	..	26	12
Metallurgy	..	..	..	..	..	..	..	13	..	..	27	..	..	40	..
Chemical Technology	2	10	..	9	13	44	19	..	..	16	61	..	27	84	44
Textile Chemistry	..	..	..	..	14	..	..	..	..	..	..	13	..	14	13
Chemical Engg.	..	35	..	..	14	..	..	17	..	..	..	..	..	66	..
Technology of Soaps, Oils & Fats	..	..	6* 12 (Diploma)	..	5	..	..	..	..	..	22	14 (Diploma) 16 (Shortterm)	..	27	6* 26 (Diploma 16 (short-term)
Pharmaceuticals and Fine Chemicals	..	..	6*	..	5	..	..	..	..	3	17	..	3	22	6*
Foods and Drugs (Chemistry of)	6	..	..	..	4	..	..	..	..	..	..	..	6	4	..
Plastics, Paints and Vernishes	..	..	..	..	4	..	..	..	..	..	..	..	..	4	..
Intermediate and Dyes	..	..	..	..	8	..	..	..	..	..	..	..	..	8	..
Automobile Engg.	..	..	20	..	..	..	..	..	49	..	..	..	..	..	69
Architecture	..	..	..	..	..	3	..	..			8	8	..	8	11
Textile Engg	..	..	..	..	..	23	..	..	..	..	..	..	..	..	23
Sanitary Engg		..	..	..	..	7	..	..		..	..	..	..	..	7
Textile Technology	..	5	22	..	..	12	..	..	24 (Cotton) 15 (Silk)	..	..	38	..	5	96 (Cotton) 15 (Silk)
Ceramics Tech.	..	..	10	..	..	..	..	..	..	2	16	..	2	16	10
Glass Technology	..	..	8	..	..	..	..	..	..	..	10	..	..	10	8
Sugar Technology	..	..	..	..	..	..	..	..	..	..	13	..	..	13	..
Sugar Engg.	..	..	..	..	..	..	..	..	..	..	..	3	..	..	3
Leather Tech.	..	5	10	..	..	..	..	..	13	..	..	..	..	5	23
Aeronautics	4	12	..	..	..	..	..	..	..	..	..	..	4	12	..
Applied Physics	8	10	..	..	..	..	..	18	..	..	..	..	26	10	..
Cinematography	..	..	15	..	..	..	..	..	..	..	..	..	..	..	15
Sound Engineering	..	..	10	..	..	..	..	..	..	..	..	..	..	..	10
Printing Technology	..	..	10	..	..	..	..	..	..	..	..	..	..	..	10

*Represent post-graduate (post B.Sc.) diploma courses).

26. From the above analytical statement, it is seen that engineering education has developed more than technological education. While facilities exist for education in all the three main branches of engineering—civil, mechanical and electrical both for the degree and the licentiate standards, the facilities for specialisation or for post-graduate training in any particular field of engineering are utterly inadequate. Facilities for education in chemical engineering have to be developed more considerably. Mining and metallurgical education have not developed to a scale commensurate with our requirements.

In the field of technological education, the available facilities are inadequate. Although courses in a large number of subjects are provided, the intake and outturn of students are small.

27. As has been stated earlier the intake of students into the well-established institutions has increased considerably in recent years, especially during 1947-48. This increased intake is likely to be maintained in the years to come. A number of new institutions have also been started, some with new courses of study and tráining not provided for at present in other institutions. Consequently, the outturn of personnel during the next 5 years will be greater than at present. On the assumption that on an average about 75% of the students admitted in the older and the newer institutions (excepting the Eastern and the Western Higher Technical Institutions will pass out every year, we have estimated in the statement below the total outturn for the next five years, due consideration being given to the year of establishment of the new institutions and the length of the course. In the following forecast the likely outturn of post-graduates and graduates from the two higher Technical Institutions proposed to be established has been excluded as it is not certain at this stage if the first batch from them will come out at all during the next 5 years. They are, however, shown separately.

STATEMENT III

Total outturn of personnel during the next 5 years 1947-52 under the existing circumstances shown zonewise.

(a), (b) and (c) indicate respectively post-graduates and research workers, equivalents graduates and diploma holders or their respective.

Subject	Southern Zone			Western Zone			Eastern Zone			Northern Zone			Total		
	(a)	*(b)*	*(c)*	*(a)*	*(b)*	*(c)*	*(a)*	*(b)*	*(c)*	*(a)*	*(b)*	*(c)*	*(a)*	*(b)*	*(c)*
Engineering—															
Civil Engineering	..	750	1,115	..	712	660	..	367	612	..	333	310	..	2,162	2,697
Mechanical Engineering	..	350	745	..	20	355	..	488	..	..	165	183	..	1,023	1,283
Electrical Engineering	..	590	690	..	28	470	..	340	53	..	330	97	..	1,288	1,310
Mechanical and Electrical Engineering (combined course).	..	..	..	..	307	155	..	..	1,083	..	919	495	..	1,226	1,733
Communication Engineering		125	145	..	27			..	..	..	..		..	162	145
Highway Engineering	..	75	..	..	..	..	..	..	..	..	..	..	..	75	..
Chemical Engineering	..	200	..	..	125	..	10	128	..	..	..	..	10	453	..
Textile Engineering	..	..	..	..	..	115	..	..	..	..	..	..	..	..	115
Sanitary Engineering	..	..	45	..	..	95	..	..	..	..	..	..	..	..	140
Automobile Engineering	..	48	235	..	..	25	..	..	234	..	..	..	..	48	494
Aeronautics	20	60	..	..	..	..	..	..	..	..	..	..	20	60	..
Architecture	..	..	..	..	..	100	..	..	..	..	42	40	..	42	140
Internal Combustion Engineering	24	..	..	..	..	..	..	..	..	..	..	..	24	..	..
Sound Engineering	..	..	95	..	..	..	..	..	..	..	..	..	..	..	95
Navigation Engineeirng	..	..	90	..	..	..	..	..	..	..	..	..	..	..	90
Power Engineering	18	..	..	..	..	..	..	..	..	..	..	..	18	..	..
Sugar Engineering	..	..	..	..	..	..	..	..	..	..	..	10	..	..	10
Technology—															
Industrial Chemistry and Chemical Technology.	10	50	..	70	..	220	107	..	..	79	329	28	266	379	200 28
Technology of Soaps,	..	..	60	..	..	..	..	..	..	8	150	70	..	..	160
Oils and Fats	..	..	30*	..	85	..	..	..	..	..	..	47	8	235	47
Textile Chemistry	..	..	..	..	80	10	..	..	..	..	..	75	..	80	85
Pharmaceuticals and Fine Chemicals	..	..	30*	..	60	..	..	..	..	10	12	..	10	72	30
Chemistry of Foods and Drugs	30	..	..	..	50	..	..	..	..	..	..	..	30	50	..
Plastics, Paints and Varnishes	..	..	..	..	30	..	..	..	..	..	..	..	..	30	..
Intermediates and Dyes	..	..	..	..	60	..	..	..	..	..	..	..	..	60	..
Sugar Technology	..	..	..	..	..	..	..	..	..	8	65	..	8	65	..
Ceramics Technology	..	..	50	..	..	..	..	..	..	10	55	..	10	55	50
Glass Technology	..	..	40	..	..	..	..	..	..	..	60	..	..	60	40
Textile Technology	..	66	120	..	33	105	..	..	Cotton 137 Silk 74	..	..	149	..	99	286 Cotton 74 Silk
Leather Technology	..	30	50	..	..	..	..	..	75	..	..	..	..	30	125
Printing Technology	..	..	95	..	..	..	..	..	..	..	..	..	..	..	95
Fisheries Technology	..	..	90	..	..	..	..	..	..	..	..	..	..	..	90
Cinematography	..	..	115	..	..	..	..	..	..	..	..	..	..	..	115
Food Technology	..	..	45	..	..	..	..	..	..	..	..	..	..	..	45
Mining	..	..	60	..	..	..	..	..	100	..	..	..	..	165	60
Metallurgy	36	..	..	..	7	..	..	..	57	..	65	..	36	246	..
Applied Physics	40	50		..	..	..	..	93	..	..	182	..	133	50	..

*Represent post B. Sc. diploma courses.

(The above statement excludes graduates and Post-graduates likely to be turned out by the Higher Eastern and Western Technological Institutetion scourse of establishment which are in the

28. The above is a forecast of the type and number of technical personnel likely to be produced by various institutions in the country during the next 5 years subject of course to what has been already stated in para. 23. If these targets are to be attained, not only should the new institutions that have been started be fully developed according to plan but the old and established ones also, which have increased the intake of students this year, should be strengthened in the matter of staff, equipment and accommodation and other facilities. The requirements of the institutions in this respect are included in the development plans of the institutions discussed below.

Development and Expansion

29. The preceding paras. give us a picture of the facilities now available in the country for engineering and technological education. This picture should be linked with that of the development and expansion projects of the institutions for the next 5 or 10 year periods so that we might get a complete picture of what we have now in respect of trained technical personnel and are likely to have during the next 5 years and what needs to be done to bridge gaps, if any between the annual output of and the requirements for technical personnel.

30. Almost all the institutions in the country have their development plans which are described in columns 10, 11, 12, 13 and 14 of the analytical statements in appendix on the institutions. These indicate the objects of the development plans, the financial implications thereof and likely increase in the intake or outturn of personnel.

The salient features of the plans are summarised in the statement below.

STATEMENT IV.

Southern Zone.

Institution	Objectives of the Plan	Increase in the intake of outturn of students	Financial Implications
1. Engineering College, Guindy.	(*a*) Strengthening of the existing staff in order to provide the best training to the students admitted. (*b*) Giving reorientations to the existing departments with a view to starting specialised courses as follows :— *Civil Engg.*—Highway Engg., Hydraulic Engg., Public Health Engg., Structural Engg., and Sil Mechanics. *Elect. Engg.*—Telecommunication Engg., Power Engg., Design and manufacture of electrical machinery and apparatus. *Mechanical Engg.*—Automotive Engg,. Production Engg., Power Plant Engg., Naval Architecture and Marine Engg. *Applied · Physics.*—Applied Chemistry and Applied Geology. (*c*) Engineering Research Development.	Provision will be made for the training of 20 students in each of the specialised courses but there will be no increase in the intake into the college.	Equipment—Rs. 63 lakhs. Buildings—Rs. 41·5 lakhs. Staff—Rs. 8·8 lakhs. Misc. recurring—Rs. 75,000. The project will have to be aided substantially by the Government of India.

Southern Zone.—contd.

1	2	3	4
2. Engineering College, Bangalore.	(*a*) Establishment of more engineering colleges in the state with an aggregate intake of 600 students into civil, mechanical and electrical engineering courses. The proposal is still under consideration. (*b*) Engineering research development. (*c*) Introduction of M. E. degree by research.	*B. E. Degree.*— Total intake into all the four colleges will be 600 but the distribution proportion among the various branches has not been indicated. M. E. Degree—6 candidates.	The details of financial implications are not given but it is understood that the total capital outlay will be Rs. 50 lakhs. No information regarding how the grants are to be met.
3. Arthur Hope College, of Technology, Coimbatore.	(*a*) Starting of Automobile Engineering Course which has been sanctioned. (*b*) Starting of post-graduate training and research in high voltage engineering, traction and mechanical transport engineering, internal combustion engineering, fuel and combustion engineering and civil engineering.	*B. E. in Automobile Engg.*— Outturn 12 candidates per years *Specialisation courses and research* :— Outturn per year.— Traction and Mech. Transport engg. 16 Internal Combustion Engg. 16 Civil Engg. 12 Elect. Engg. 12 Fuel & Combustion Engg. 12	*Capital.*— Equipment—Rs. 24·5 lakhs Buildings—Rs. 6·00 lakhs *Recurring.*— Staff—Rs. 1·72 lakhs. Misc. recurring—Rs. 1·55 lakhs. The Government of Madras have sanctioned high voltage engineering courses and therefore the grants required. Buildings—Rs. 1·5 lakhs. Equipment—Rs. 6 lakhs and staff Rs. 27,600 would be provided by the Government of Madras. The rest of the grants for the development of the projects will have to be met by the Government of India.
4. College of Engg. Trivandrum	(*a*) Giving the existing departments reorientations in order to start specialised training in civil engineering, structural Engg. highway engineering, public health engineering and irrigation engineering. *Mech. Engg.*— Power Engg. and Production engg. *Electrical Engg.* High voltage engineering, Power Supply Engg. and Communication engg. (*c*) Starting a polytechnic attached to the college for diploma and certificate courses in textiles, elec. engineering, civil engineering, sanitary engineering, irrigation engineering, mechanical engineering, workshop foremansihp, oils and fats technology, printing, archtecture etc.	The increase in intake into the college will be 10 students, the present intake being 50. Provision will be made for specialised study as follows : Irrigation engg. 10 Public Health Engg. 4 Highway Engg. 8 Structural Engg. 12 Production Engg. 4 Power Engg. 4 Power Supply Engg. 5 Communication Engg. 3	*College.*— Buildings—Rs. 6·036 lakhs. Equipment—Rs. 13·00 lakhs. Recurring—Rs. 7·00 lakhs/yr. Hostel Bldg.—Rs. 8·1 lakhs *Polytechnic.*— Buildings—Rs. 6 lakhs. Equipment—Rs. 3 lakhs. Recurring—Rs. 1·5 lakhs The University of Travancore have sanctioned a capital grant of Rs. 3 lakhs for the Polytechnic. The rest of the grants required have to be contributed according to the authorities by the Government of Travancore and Government of India on 50 : 50 basis.

Southern Zone.—contd.

1	2	3	4
5. College of Engg. and Technology, Annamalai University.	(a) Completion of the scheme for Engg. and Technological education and bringing up the training facilities to the standards laid down by the AICTE. (b) Engineering Research Development.	No. consequential increase has been envisaged but it might be possible to increase the intake by 50 per cent or 50 students. The research development plan provides facilities for the training of a number of research workers.	College Bldgs.—Rs. 8 lakhs. Hostel Bldgs.—Rs. 10 lakhs. Staff quarters—Rs. 13·5 lakhs Equipment—Rs. 34·5 lakhs. Staff—Rs. 3·316 lakhs. Misc. recurring—Lakhs/year. Misc. recurring—Rs. 27,000. The University has applied to the AICTE for an endowment grant of Rs. 60 lakhs estimated to yield and interest of Rs. 1·5 lakhs annually, a recurring block grant of Rs. 3·5 lakhs and bldg. and equipment grant of Rs. 70 lakhs.
6. Alagappa Chettiar College of Technology, Madras.	Completion of the scheme for organising technological education and research in chemical engineering, leather and textile technology by completing construction of bldgs. purchase of equipment and appointing the full complement of staff. It is also intended to include within the scope of the institution textile Chemistry, rubber technology heavy chemical industry, and ceramics later on.	No consequential increase in intake has been envisaged. But if required, 30 more students can be taken into each of the three courses *viz.*, chemical engg. leather technology and textile technology.	Equipment—Rs. 5 lakhs. Buildings—Rs. 12 lakhs. Staff—Rs.2·2 lakhs. The Government of Madras have contributed Rs. 5 lakhs and Dr. Alagappa Chettiar Rs. 5 lakhs towards the establishment of the college. The rest will, it is expected be provided by the Madras University failing which the Government of Madras will have to provide.
7. Sri Krishnarajendra Silver Jublee Technological Institute, Bangalore.	(a) All-round strengthening of the existing facilities commensurate with the increase in the admissions. (b) Development of a Textile Testing Laboratory for the standardisation of textile goods from the view point of the consumer.	No consequential increase has been envisaged but with the expanded facilities 8 more trained students can be produced every year.	Buildings—Rs. 3 lakhs. Equipment—Rs. 4·2 lakhs. Staff and Miscellaneous Recurring—Rs. 25,000. The proposals are under the consideration of the Government of Mysore and it is not known if the Mysore Government would finance the projects.
8. Indian Institute of Science, Bangalore.	(a) Aeronautical engineering, fundamental education and research in aerodynamics and aeronautical designs developmental research and carrying out 'flying tests' for the industry. (b) Communication engineering.—Extension of research facilities to cover all latest advances in the field such as for instance Frequency Modulation, Picture Transmission, Radar and Microwave propogation etc., Extension of the existing course from 1 year to 2 years in order that the course may comprise advanced studies as well.	No consequential increase in intake or outturn has been envisaged but facilities will be available for the training of a good number of research workers.	Capital—Rs. 195 lakhs. Recurring—Rs. 7 lakhs.

Southern Zone.—contd.

1	2	3	4
	(*c*) Internal Combustion Engineering.—Establishment of a Gas Research Section ; and Departmental expansion so that the facilities may compare with those elsewhere in the world.		
	(*d*) Metallurgy.—Development of Pure and Applied Research in the field.		
	(*e*) Electrical Technology and Power Engg., Establishment of a Traction Engineering Section and expansion of teaching and research facilities in the light of prevailing conditions.		
9. Institute of Leather Technology, Madras.	Expansion of the activities of the institute both in respect of teaching and research. Greater stress is laid on research on Indian tanning materials, tanning of leather etc.	8 more candidates will be trained for the diploma course ; and a good number in research.	Buildings—Rs. 3.5 lakhs. Equipment 1·5 lakhs Staff and Misc. Recurring—Rs. 75,000.
10 Institute of Textile Technology, Trivandrum.	(*a*) Institution of B.Sc. (Tech). in Textiles course of four years' duration. (*b*) Expansion of the existing diploma course in all the three branches.	(*a*) Intake into the new course—B. Sc. (Tech.) - 20 students per year. (*b*) Increase in the intake into diploma 8 into each of the three branches.	Buildings—Rs. 5 lakhs. Equipment.-Rs. 6 lakhs. Recurring—Rs. 50,000/yr. to be shared on a 50 : 50 basis between the Government of Travancore and the Government of India.
11. Sri Jayacharmarmarjendra Occupational Institute, Bangalore.	(*a*) Introduction of Chemical Engineering course. (*b*) Development of manufacture of electrical goods, scientific instruments, etc.	100 more canididates can be trained in various branches.	Buildings—Rs. 5 lakhs. Equipment—Rs. 15 lakhs. Recurring—Rs. 15,000/yr. No information as to how the grants are to be met.
12. Maharaja's Technological Institute, Trichur.	(*a*) Institution of degree courses in Civil, Mechanical, Electrical and Marine Engineering. (*b*) Inclusion of Textile Technology and Automobile Engg. into the diploma courses.	(*a*) Degree—40 candidates in each of the three main branches of engineering. (*b*) 35 candidates in each of the two new courses for the diploma.	Buildings—Rs. 5 lakhs. Equipment—Rs. 5 lakhs. Recurring—Rs. 72,000. To be shared on 50 : 50 basis between the Government of Cochin and the Government of India.
13. Kerala Soap Institute Calicut,	Expansion of the existing training facilities and starting a separtate soap and oil technological institute for a 3-year diploma course in the technology of soaps, oils and fats as well as for research.	The new diploma course will train 24 students per year.	Buildings—Rs. 1 lakh. Equipment—No information. Staff—Rs. 42,500/yr.

Southern Zone.—concld.

Institution	Objectives of the plan	Increase in the intake or otturn of students year.	Financial Implications Capital Recurring.
14. Seven Polytechnics of the Government of Madras at Madras, Mangalore, Madura, Coimbatore, Vuyyur, Coconada, Calicut.	(*a*) Completion of the scheme for the establishment of the seven polytechnics at various centres. (*b*) Inclusion of certain new subjects in the polytechnics as follows :— *Calicut*—Civil Engg. *Mangalore*—Fisheries Technolgoy and Navigation. *Madura*.—Sanitary and Radio Engineering. *Vuyyur*.—Sanitary Engg. Chemical Engg. and Food Technology. *Coconada*.—Automobile and Radio Engineering.	The consequential increase in the intake is 20 students into each of new courses. in each polytechnic.	Buildings.— Polytechnics—Rs. 45 lakhs. Hostels—280,000 sq. ft. Floor area, cost not estimate. Equipment—Rs. 46 Lakhs. Recurring—Rs. 26 lakhs. per year. The proposals are under the consideration of the Government of Madras but no information is available as to what extent the Government would meet the requirements.
15. College of Science and Technology, Andra University.	General expansion of facilities for teaching and reserch in technology with consequential increase in the intake and outturn of students	*Additional outturn of Post-graduate course*.—Chemistry of Foods and Drugs. . 4 Applied Physics including optics . . . 10 *Degree Courses*.—Applied Physics including optics . 10 Chemistry Technology . 12 Post-graduate course in analytical chemistry . 2	Capital—Rs. 13·37 lakhs. Recurring—Rs. 217 lakhs. The above is for the development plan of the whole institution which includes the Departments of Science also The details of the develop ment plan for the Science Departments are given. separately at late stage under 'Higher Scientific Education and Research'. The entire grant is to be made by the Government of India.

Eastern Zone

			(In lakhs of Rupees)	
1 Department of Applied Physics, Calcutta University.	Provision for additional space, staff and equipment to run the Department efficiently; Provision for better facilities for research to members of the staff and a hostel to accommodate 50 students ; To double the admission number for Post-graduate and Research Courses, Addition of more electives and introduction of new branches of research.	*Additional outturn*.— Post-graduate courses & research in applied Physics : 21	6·05	0·45
2 Department of Applied Chemistry, Calcutta University	Provision for additional staff, space and equipment to run the Department efficiently ; and to double the existing intake to Post-graduate and Research Courses ; Introduction of new branches of research and addition of more electives.	*Additional outturn*.— Post-graduate courses and research in Applied Chemistry : 28	19·20	0·65

1	2	3	4	
3 College of Engineering and Technology, Jadavpur.	Provision for adequate facilities for staff, accommodation and equipment for efficiently educating a student body of 1200 at Degree standard in Elect., Mech., and chemical engineering courses, Initiation of a tutorial system of instruction of Improvement of curriculum by addition of 23 elective subjects, Creation of Research Departments in close co-operation with industries and introduction of post-graduate courses in the above subjects of engineering, Opening of 7 new courses of study upto Degree standard in Civil, Textile, Geological, Agricultural Building and Architectural, Military & Aeronautical Engineering, Construction of Hostels and staff quarters to make the college a residential institution, Revision of existing scales of pay for the staff, Creation of a separate institution in the nature of a trade school which would absorb the existing shorter Diploma courses in addition to new subjects to be introduced and Provision of facilities to young members of the staff to receive specialised training abroad.	*Additional outturn:*— *Chemical Engg.*— Post-graduate courses and Research 12 Graduate courses 20 *Physical Chemistry* :— Post-graduate Research : 3 *Refrigeration Engg.*— Post-graduate and research : 3 *Electrical Engg* — Post-graduate & Research 3 Graduate courses : 30 *Mechanical Engg.*— Postgraduate & Research 11 Graduate Courses 30 *Military Engg.*— Graduate Courses 8 *Aeronautics.*— Graduate Courses 8 *Diploma Courses* : Eléct. & Mech. Engg. 27 Civil Engg. 38 *Civil Engg.*— Graduate Courses , 22 *Textile Engg.*— Graduate Courses 8 *Geological Engg.*— Graduate Courses : 8 *Building & Architecture.*— Graduate Courses 8	124·43	5·87
4. Bengal Engineering College, Sibpur.	*Immediate Plan* :—Increasing the strength of the student body to 520 in place of the normal strength of 300, Improvement in the curriculum of studies, Better teachers & teaching, Greater ranger of degree courses and Research Programme, Development of closer & more continuous liaison between the Institution & Industry & Government Departments. 5-*Year Plan* :— Aims at further increasing the number of students to 1200 and providing complete modern training and instruction in Engineering Architecture, and in certain branches of Post-graduate and Research work, for developing in the province a type of young engineer that the modern world requires, comparable to those of the best institutions of the west.	*Additional Outturn.*— *Postgraduate & Research.*— Civil, Mech., Elect., Met. Engineering . .48 *Graduate Courses.*— Civil Engg . . . . 45 Mech. Engg. . . . 45 Elect. Engg. . . . 20 Met. Engg. . . . 3 Architecture . . . 15	98·86	11·67

1	2	3	4	
5. Eastern H.T. I., Kharagpur	(*i*) Provision for under-graduate courses in Aeronautical Engg. Chemical Engg., Civil and Sanitary Engineering, Elect. Engg., Mechanical Engg., Architecture, Metallurgy, Botany, Meteorology, Geology and Geo-Physics with a total annual intake of 570 students.			
	(*ii*) Provision for Post-graduate courses and Research in Fuel Technology, Pharmaceuticals and Fine Chemicals, Regional Planning Paper Technology, Glass and Ceramics, Plastics, Paints and Pigments, Hydraulics & River Research Transportation (including Railway Engg,) Structural Engineering (including High Dams), Design of Elect. Machinery, Refrigeration & Air-conditioning, Automobile Engg., Machine Tools, Design of Machinery & Instruments, Light alloys, Industrial Physics, Electronics, Economic Botany, Geo-Physics, Geology, Minerology, Meteorology and Food Technology with a total annual intake of about 500 students	Details are given in the previous column	304·95	44·61
	With a view to ensuring an adequate supply of higher types of technical personnel which will be required for industrial development & research in the country as also to meet the acute shortage of the superior cadre of technical teachers, it has been proposed to establish this Higher Technical Institution on the lines of the M.I.T			
6. Calcutta Engg. College, Ballygunge.	To cope with the extra pressure of new admission (260 students) the scheme envisages provision of additional class rooms, laboratory and workshop accommodation adequate hostel accommodation for 600 students, additional equipment and additional teaching, administrative and other staff.	*Diploma Courses*:— Civil Engg . . . . 50 Elect. & Mech. Engg. . 200	16·45	2·80

Eastern Zone.—contd.

1	2	3	4	
7. Bengal Textile Institute, Serampore .	Provision for a degree course (3 years) in Textile Technology, an Operatives Training Course for 6 months, an artisans courses for 1 year, Adequate expert staff laboratory, equipment and research facilities and a number of research scholarships. The number of new admissions are : Degree Course ....40 Operatives' Training Course..............112 Artisan Course 60	*Degree Courses* :— Textile Technology . 30	5 35	1·79
8. Bengal Silk Technological Institute, Berhampore, West Bengal.	Provision for facilities for higher theoretical and practical training and to carry out research in silk manufacture. Under the scheme it is proposed to raise the standard of training imparted at the institute, by employing more efficient staff and the addition of special equipment. Intake —40	*Degree Courses.* — Silk Technology . . 15 Wool Technology . . 8 Artificial Fibres Tech. . 8	1·00	0·50
9. Sericultural Training Institute.	To train sericultural staff for development work in the villages on scientific lines. It is proposed to offer a Senior Course of Training (Degree) and a Junior Course of non-matric students.	*Senior Course* (*Degree*).— Sericulture : . . . 6	3·53	0·91
10. Bihar College of Engg. 11. Sindri Engineering College, Sindri.	There was previously a development plan which envisaged provision of facilities for converting the college into a first-grade engineering institution. But this has been abandoned in favour of the establishment of a first-grade institution at Sindri which proposed to offer under-graduate and post-graduate courses in elect. & mech. engineering with facilities for research work in these branches. The plan is still under the consideration of the Bihar Govt. Intake E.E. 30 M.E. 30	*Outturn* *Degree courses* Elect. 25 Mech. 25	Not known	Not known

1	2	3	4	
12. Calcutta Technical School, Calcutta.	*Short-term plan.* To cope with the increased number of admissions the scheme proposes—(*i*) to treble the existing accommodation for class rooms and Laboratories ; (*ii*) To construct an examination hall, two common-rooms, a store room, a machinery and a library (*iii*) to provide requisite additional staff and equipment for the various laboratories *Long-term plan.*— Initiation of the following new courses of study of Diploma standard :— Welding (gas and Electric), Printing, Textile Machinery, Paper manufacture, Automobile Engg., Marine Engg., and Naval Architecture, Draughtsmanship, Ceramics, Soap making and Plastics	*Additional Outturn Diploma Courses.*— Elect. & Mech. Engg. . 25 Elect Engg. . . . 20 Printing Tech. . . 7 Textil technology . . 7 Paper Tech. . . . 7 Automobile Engg. . . 7 Marine Engg. And Naval architecture . . 7 Draughtsmanship . . 7 Ceramics . . . 7 Soap Technology . . 7 Plastics . . . 7	*Short term plan* — 13·50 *Longterm Plan* 7·15	 0·75 0·57
13. B. N. R. Technical Institute, Kharagpur 14. Kanchrapara Technical School, Kanchrapara 15. E.I.R. Technical Institute, Jamalpur	Not known		Not known	Not known
16. Jamshedpur Technical Institute, Jamshedpur	No plan for development.			
17 Bengal Tanning Institute, Calcutta	(*i*) Improving the status of the existing staff, Expansion of the Demonstration Tannery by import of modern machineries, Establishment of a machine equipped Boot and Shoe School and construction of a Students' Hostel: (*ii*) Provision of adequate facilities researches on (*a*) The fundamental of leather science' (*b*) The technique of leather manufacture (*c*) Leather auxiliaries including Tannery, chemicals, Synthetic Tanning, synthetic leather, leather dressings, fat liquors, etc.	*Diploma Courses Outturn*:— Tanning . . . . 6 Leather Goods manufacture 6 Leather Chemistry. . . 6	4 49	1·02

Eastern Zone.—contd.

(1)	(2)	(3)	(4)	
18. Orissa School of Engg., Cuttack.	Starting of a new section in Elect. Mech. Engineering with an additional intake of 70 students, Provision of adequate accommodation and equipment.	*Diploma Courses Additional Outturn.* Civil Engg. . 80 Elect. & Mech. Engg. . 60	5.00 (As per interim plan submitted by the Utkal University for the consideration of the Committee).	0.90
19. Balasore Technical School, Balasore, Orissa.	Expansion and development of the existing workshops by which more students can be trained in the Technical Diploma Course, Construction of new buildings and provision for requisite equipment for the Blacksmithy workshop.	..	0.35	0.06
20. The Indian School of Mines, Dhanbad.	Reorganisation of the institution in the light of the recommendations of the Reorganisation Committee envisaging a general increase in the intake of students from 24 to 60 comprising 48 mining and 12 applied geology students, revision of the curriculum by replacing the 3-year certificate course by a full 4-year course leading to diploma in either mining engineering or geology (the diploma being equivalent to M.Sc. degree of Indian Universities) and Metal Mining and Surveying and bringing the Departments of Physics and Mathematics within the scope of the Eng. Department, Revision of the existing scales of pay of the staff, Improvement of physical facilities, Introduction of a scheme of Post-graduate training the cost of which to be shared by the Government and the Industry ; Provision effective practical training and for Research fostering co-operation between Industry and the Institution.	*Additional Outturn.* Mining . . 20 Applied Geology 10	28.16	3.6

Northern Zone

1. College of Engineering and Technology, Aligarh University.	Introduction of Hons. courses in engineering ; starting of courses in communication engineering, aeronautics, agricultural engg, chemical engg. and metallurgical engg, construction of new bluidings, increase in the strength of the teaching staff and providing for adequate equipment.	*Degree courses* Civil Engg. . . . 40 Mech. Engg. . . 16 Elect. Engg. . . 10 *Diploma Courses.* Civil Engg. . . . 75 Elect. Engg. . . 19 Mech. Engg. . . 40	Capital . Rs. 53.07 lakhs Recurring . Rs. 2.62 „	

Northern Zone—contd.

(1)	(2)	(3)	(4)
2. College of Mining and Metallurgy, Benares Hindu University.	Increase in the intake of students by 50 per cent. introduction of degree course in fuel technology training members of staff abroad in metallurgical practice.	Metallurgy . . . 10 Mining . . . 6 Fuel Technology . . 20	Capital —Rs. 14.655 lakhs Recurring —Rs. 8.3 „
3. College of Engg., Benares Hindu University.	Starting of separate degree courses in elect. and mechanical engineering ; starting of courses in aeronautical engineering and civil engineering.	Elect. Engg. . . 30 Mech. Engg. . . 45 Aeronautics . . . 20 Civil Engg. . . . 65	Capital —Rs. 44.00 lakhs Recurring —Rs. 9.80 „
4. Thomason College of Engineering, Roorkee.	Introduction of separate 3-year courses in Elect. and Mechanical engineering subjects ; starting of a 4-year course in chemical engineering in conjunction with Harcourt Butlar Technological Institute ; starting of one year post-graduate course in each of the branches of electrical, mechanical and civil engineering subjects ; starting of courses with appropriate selection of subjects for students desirous of joining post-graduate colleges of aeronautics in India, U.K. & U.S.A., starting of short refresher courses for engineers already in service.	*Post-Graduate Courses.* Civil Engg. . . . 10 Mech. Engg. . . 10 Elect. Engg. . . 10	Capital —Rs. 8.92 lakhs Recurring —Rs. 1.75 lakhs
5. Technical College, Dayalbagh.	Introduction of degree courses in Elect. and Mechanical engineering; starting of new courses in automobile engineering; chemical engg., road communication engineering and hydro-electric technology.	*Diploma holders 50% increase.* Graduates: Elect. . . . . . 25 Mech. 25	Capital—Rs. 18.25 lakhs Recurring—Rs. 1.75 lakhs
6. College of Technology, Benares Hindu University.	Expansion of research facilities for glass technology, pharmaceutical chemistry; increase in the intake into ceramics technology both for degree and post-graduate courses.	*Ceramics Technology.* Degree. . . . . 30 Post-graduate . . 8	Capital—Rs. 4.34 lakhs.
7. Harcourt Butler Technological Institute, Nagrore.	Installation of complete experimental Oil Mill, Soap Factory and oil refinery ; introduction of courses in chemical engineering, heavy chemicals, fine chemicals, Foods and Drugs, pharmaceuticals, fermentation technology, and introduction of mechanical and electrical engineering courses.	Elect. Engineering . 30 Mech. Engineering . 30 Details of outturn of personnel in other courses are not available.	Capital—Rs. 21.25 lakhs. Recurring—Rs. 10·70 Lakhs.

Northern Zone.—contd.

(1)	(2)	(3)	(4)
8. Indian Institute of Sugar Technology, Cawnpore.	Construction of permanent buildings for the institute details of the plan are receiving the attention of Indian Central Sugar Cane Committee.	Details are not available	
9. Delhi Polytechnic . .	Introduction of degree courses in electrical, mechanical and all-India diploma courses in civil and chemical engineering, chemical technology, and commerce. Full professional courses in art, architecture . and textile technology in addition to the existing courses are also contemplated.	*Ultimate Outturn ; Degree Courses.* Elect. Engg. . . 20 Mech. Engg. . . 20 Civil Engg. . . . 30 *All-India Diploma Courses* (Enquivalant to Degree) Bldg. & Structure . 23 General Chem. Tech. . 26 Tech. of Paints & Oils . 10 Tech. of Heavy Chemicals 10 Ceramicsi . . . 8 Elect. Engg. . . 30 Mech. Engg. . . 30 Civil Engg. . . . 30 Textile Tech. . . 20 *All-India Certificate Courses* Structural Engg. . . 10 Textile Chemistry . 8 Elect. Engg. . . 20 Mech. Engg. . . 20 Civil Engg. . . . 20 Chemical Technology . 10 (Part-time).	Capital—Rs. 91.2 lakhs Recurring—Rs. 9.61akhs
10. Birla Engineering College, Pilani.	Building up of and equipping a first-grade engineering institution with provision for training in electrical, mechanical, civil aeronautical, textile and production engineering branches.	....	Capital—Rs. 45 lakhs Recurring—Rs. 1.5 lakhs additional.

(The institution was established in 1946 and it is too early now for it to have any well defined development plan. However, the above indicates the lines of future develop ment. No further details are available at this stage.)

Western Zone

Institution	Objectives of the plan	Increase in the outturn of students/year	Financial Implications
1. Department of Chemical Technology, University of Bombay.	General expansion of research and educational facilities in the institution with a view to increasing the admissions into the various courses as in the following: Textile chemistry-20, Chemical engineering -20, Intermediates and dyes -10, Oils, Fats and Soaps -10, Plastics, Paints and Varnishes -10, Foods & Drugs -10, Cellulose & Paper Technology -10, Research Scholars-80.	The outturn will be approximately 75% of the intake shown in the previous column.	Capital—Rs. 19·6 lakhs. Recurring—Rs. 3·5 lakhs.
2. Lakshmi Narayan Institute of Technology, University of Nagpur.	Completion of the scheme for reorganization of the Institute and expansion of facilities for increasing the intake of students into B.Sc. (Tech.) and research courses; separate courses in Chemical Eng. and Oil Technology have been started; Starting of short-term diploma courses in soaps, paints and varnishes, cosmatics, perfumes, glass blowing, pharmaceuticals and fine chemicals, food preservation, analytical chemistry, electro plating, machine drying and workshop practice and photography. Development of research in fuels, pigments, paints and varnishes. C.P. coals, refractories, etc.	Details relating to additional outturn of students in the various courses are not available, but it is expected that the final outturn will be 72 B.Sc. (Tech.) 4—8 students will be trained in each of the short-term courses.	In addition to Rs. 15 lakhs capital and Rs. 1 lakh recurring already sanctioned by the Government of C. P. & Berar the following grants would be required for research development short-term courses and expansion projects: Capital. Rs. 2·5 lakhs Recurring—Rs. 2·1 lakhs
3. College of Engineering, Poona.	Starting of a course in metallurgy from 1948 onwards leading upto the B. E. degree; starting of Central Engineering Test House for the Bombay Presidency. The Government of Bombay have sanctioned the scheme and intend establishing a small nucleus laboratory for soil mechanics, cement road test tract, timber, design, etc.	The outturn of students in metallurgy—8- has already been considered earlier.	Capital—Rs. 29·41 lakhs. Recurring—Rs. 2·5 lakhs of which the Provincial Government will contribute Rs. 6·52 lakhs and Rs. 66,000 respectively for capital and recurring. The balance is to be sought from the Central Government.
4. Engineering College, Jubbulpore.	There is no development plan other than full establishment of the institution, which has just been started.	The total outturn when the institution is established will be about 60 in all the branches of engineering civil, mech, elect. and communication engg.	The scheme for the establishment of the institution entails a Capital of Rs. 87 lakhs. No details are available regarding the implications.
5. Kala bhavan Technical Institute— (Development plan envisages the establishment of a new Engineering College in Baroda).	It is understood that a scheme for the establishment of an Engineering College in Baroda an estimated cost of Rs. 26 lakhs capital and Rs. 3 lakhs recurring has been sanctioned by the Baroda Government. No details of the scheme are, however, available at this stage.		
6. **Western Higher Technical Institution.**	The details of the institution, which is to be established, have been referred to earlier.		

Southern Zone

31. From the data presented in Statement IV it is found that the development projects of most of the established engineering colleges in the zone relate chiefly to reorientation of the existing departments with a view to providing advanced training in various specialised lines of engineering such as for instance, Hydraulic and Irrigation Engineering, Public Health Engineering, Soil mechanics, Power Plant Engineering, Production Engineering etc. and very small increase in the outturn of general, civil, mechanical and electrical engineering graduates has been envisaged. Great stress has been laid in the plans on the development of engineering and technological research in the institutions, which is indeed of interest. The engineering college of the Annamalai University, however, does not contemplate introduction of specialised courses. Its main concern is to build up the training facilities for the training of general, mechanical, civil, electrical and chemical engineering students upto the degree standard by providing staff, equipment and buildings which are sadly lacking now. It is anticipated that, consequent on the expansion of the facilities, the college would be in a position to increase the intake by 50% if necessary. Research development also forms a part of the project Establishment of four more engineering colleges in Mysore State, with an aggregate intake of 600 students, has been proposed but no details of the project are available. Maharaja's Technological Institute, Trichur, evisages institution of degree courses in civil, mechanical, electrical and marine engineering in addition to the existing diploma courses in textile technology and automobile engineering. The Institute of Textile Technology also intendes starting degree courses in textile technology as well as increasing the intake of students into the diploma courses. Other technical institutions, especially the Silver Jubilee Technological Institute, Bangalore and the Institute of Leather Technology, Madras, intend mainly to improve the facilities for teaching as well as for research. It should be possible to increase the intake of students into the institutions, as a result of such improvement. The Alagappa Chettiar College of Technology, which is now in a formative stage, proposes to fully implement the scheme of organising technological education and research in chemical engineering, textile technology and leather technology by completing the construction of buildings, procurement of equipment and appointing full complement of staff. No consequential increase in the intake of students has been envisaged, but if required the intake into each of the courses could be increased from 20 to 50 students. The plan for the Kerala Soap Institute is interesting in that the present one year diploma course in the technology of soaps, oils and fats will be modified and the course will be extended to 3 years with an intake of 24 students per year. The seven new Polytechnics of the Madras Government which are now in a formative stage will be fully developed according to plan and new subjects will be included in some of the polytechnics. The Jayachamarajendra Occupational Institute intends introducing diploma courses in chemical engineering and at the same time improving the facilities for the development of manufacture of electrical goods, scientific instruments etc. It is also intended to increase the number of trainees in the various branches by 100. The development plan of the Indian Institute of Science has numerous features, the chief of which are extension of research facilities in the departments of electrical technology, communication engineering, aeronautics, internal combustion engineering and metallurgy by way of staff, equipment and accommodation. It is proposed to establish at the institute a Gas Turbine Research Section in the Department of Internal Combustion Engineering for fundamental Research as well as for the development of new designs. The establishment of a Traction Engineering Section in the Department of Power Engineering has also been contemplated.

Western Zone

32. The most important development in engineering and technological education in the Western Zone is the establishment of the Western Higher Technical Institution for post-graduate training and research as well as for training upto the degree standard in the various branches of engineering and technology. The details of the intake and outturn into each of the courses in the institution have been referred to earlier in this section. When fully established, the institution will provide for about 1,000 students at a time in the post-graduate and research departments and for about 660 students for the graduate courses. In addition to this new institution, it is understood that a scheme for the establishment of an Engineering College in Baroda at an estimated cost of Rs. 26 lakhs capital and Rs. 3 akhs recurring, has been sanctioned by the Baroda Government. Details of the scheme are, however,

not available at this stage. In technological education and research, the two institutions in the zone have development plans which envisage increase in the intake of students into the various courses of study in chemical technology and chemical engineering. The Department of Chemical Technology, University of Bombay, intends expanding the research and training facilities in the institution with a view to increasing the admissions into the various courses—textile chemistry, chemical engineering, intermediates and dyes, soaps, oils and fats, plastics, paints and varnishes, pharmaceuticals and fine chemicals, foods and drugs, cellulose and paper technology. In addition, provision will be made for an additional number of research scholars at the institution. The Lakshminarayan Institute of Technology will complete the scheme for reorganization of the institute and expansion of facilities for increasing the intake of students into research and degree courses in chemical technology. Separate courses in chemical engineering and oil technology will be introduced. In addition, the institution proposes to introduce short-term courses in various technological subjects as for instance, soaps, paints and varnishes, cosmetics, perfumes, pharmaceuticals, food preservation, analytical chemistry etc. Research development in the field of fuels, pigments, paints and varnishes and refractories has also been proposed. The College of Engineering, Poona, will start from 1948 a degree course in metallurgy with an annual outturn of 8 students. It has also been decided to start at this institution a Central Engineering Test House for the Bombay Presidency—a scheme which has been approved by the Bombay Government.

Northern Zone

33. All the engineering institutions in this zone have development plans which envisage introduction of specialised courses in engineering as well as increase in the intake of students into the various courses. Some of the institutions which are at present offering courses upto licentiate or junior standard have proposed to introduce courses upto degree standard as well. The College of Engineering and Technology, Aligarh University, contemplates introduction of specialised courses in communication engineering, aeronautics, agricultural engineering, chemical engineering and metallurgical engineering. The College of Engineering, Benares Hindu University which is at present offering combined courses in mechanical and electrical engineering has plans for starting separate degree courses in these subjects as well as in aeronautical engineering and civil engineering. The details of the intake and outturn of students into these reorganised courses are shown in the statement. The Thomason College of Engineering, Roorkee, has already started from this year degree courses in civil, mechanical and electrical engineering. The development of the institution envisages introduction of a 4 year degree course in chemical engineering in conjunction with Harcout Butler Technological Institute and an one year post-graduate course in electrical, mechanical and civil engineering. The details of the intake and outturn into the chemical engineering courses are, however, not available. The Technical College, Dayalbagh which is at present a junior technical institution, has plans for the introduction of degree courses in electrical and mechanical engineering as well as for increasing the outturn of diploma holders by 50%. It also contemplates starting new courses in automobile engineering, chemical engineering, road communication engineering and hydro-electric technology. Details in respect of the last portion of the development plan are not available. The development plan of the Delhi Polytechnic envisages introduction of degree courses in electrical, mechanical and civil engineering affiliated to the Delhi University, as well as increasing the intake of students into the All-India Diploma Courses and All-India Certificate Courses in the various branches of engineering and technology. The details of the ultimate outturn in each of the courses when the plan is fully implemented are shown in the statement. The Birla College of Engineering, Pilani, which has been started only this year will be fully developed during the next five years and will have provision for training in electrical, mechanical, civil, aeronautical, textile and production engineering branches. Details of the intake and outturn into the aeronautical, textile and production engineering courses are not available.

34. In technology, the College of Mining and Metallurgy, Benares Hindu University, contemplates increasing the intake of students by 50% into the metallurgical and mining courses. It is also intended to introduce a degree course in fuel technology in the institution with an outturn of about 20 students per year. The College of Technology of the same university has plans for expansion of research facilities in glass technology and pharmaceutical chemistry. It is also contemplated to increase the intake into the ceramics technology course—both degree and post-graduate standards. The Har-

cout Butler Technological Institute, Cawnpore, has plans for the introduction of degree courses in mechanical and electrical engineering as well as in chemical engineering, heavy chemicals, fine chemicals, foods and drugs, pharmaceuticals, fermentation technology etc. The expected outturn of electrical and mechanical engineers from the institution will be 30 each. Details of outturn of personnel in other courses are not available.

Eastern Zone

35. The most important development of technological education in this zone is the establishment of Eastern Higher Technical Institution which has already been referred to in detail earlier in this section. This institution when completed will provide facilities for the post-graduate training of about 500 students and for the graduate training of about 570 students in engineering and technology. The details of the various subjects of study and research at the institution are furnished in the statement. All the well-established engineering and technological institutions in the zone have plans for increasing the present facilities by way of staff, equipment and buildings, both for teaching as well as for research. Such expansion, it is contemplated, would result in an increase in intake and outturn of students in the various courses. At the same time post-graduate and specialisation courses in engineering and technology have been envisaged in the development plans of at least two institutions, namely, the College of Engineering and Technology, Jadavpur and the Bengal Engineering College, Sibpur. The development plans of these institutions also envisage establishment of close relationship with industry so that they might cater to the needs of the latter both in the matter of training of personnel and in research development. The College of Eingineering, Jadavpur, intends starting 7 new courses of study upto the degree standard—in civil, textile, geological, agricultural, building and architectural, military and aeronautical engineering subjects. Post-graduate courses in civil, mechanical and electrical engineering have also been contemplated in the plans of the Jadavpur College of Engineering and Sibpur College of Engineering. In Textile technology, the Bengal Textile Institute, the Bengal Silk Technological Institute and the Sericultural Training Institute, all have plans for introduction of degree courses in textile technology and its various branches as for instance, silk technology, wool technology, artificial fibre technology etc. The Bengal Tanning Institute has plans for providing adequate facilities for research on the fundamental and applied aspects of leather technology and leather chemistry, including synthetic tanning, synthetic leather etc. Following on the recommendations of the Reorganisation Committee the Indian School of Mines, Dhanbad, has envisaged plans for a general increase in the intake of students from 20 to 60, comprising 48 Mining and 12 Applied geology students ; and revision of the curriculum by replacing the 3 year certificate course by full 4 year course, leading to diploma in either mining engineering or geology. Improvement of the existing facilities in regard to staff, equipment and accommodation, introduction of scheme of post-graduate training in mining in cooperation with the industry and provision for effective practical training for students and for research are some of the highlights of its development programme.

36. The following statement indicate the likely increase in the annual outturn of various categories consequent on the implementation of the development projects.

STATEMENT IV

Increase in the outturn of personnel/year consequent on the implementation of the Development plans

(a, b, & c indicate respectively post-graduates of diploma holders or their respective equivalents)

Subject	Southern Zone			Western Zone			Northern Zone			Eastern Zone			Total		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
Engineering															
Civil Engineering	12	280	..	..	45	..	10	165	95	17	115	175	39	605	270
Mechanical Engineering	..	173	..	..	67	6	40	136	60	23	180	..	63	556	66
Electrical Engineering	11	128	..	..	67	..	40	88	39	23	135	20	74	418	59
Mechanical and Elect. Engineering	..	..	..	..	..	..	..	..	12	..	..	312	..	..	324
Communication Engineering	..	18	..	..	..	..	..	..	..	..	..	..	..	18	..
Highway Engineering	..	21*	..	..	..	..	..	..	..	..	..	..	..	21	..
Chemical Engineering	..	32	..	..	82	..	..	..	..	14	80	..	14	194	..
Textile Engineering	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sanitary Engineering	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Automobile Engineering	..	9	..	..	..	..	..	..	10	..	..	7	..	9	17
Aeronautics	..	..	..	..	..	..	..	20	..	..	48	..	..	68	..
Metallurgical Engg.	..	..	..	..	23	..	..	..	..	7	..	..	7	23	..
Building Engineering and Architectural Engineering.	..	..	..	..	67	..	..	..	..	..	83	..	..	150	..
Military Engineering	..	..	..	..	..	..	..	..	..	..	8	..	..	8	..
Marine Engineering and Naval Architecture	..	15*	..	..	67	..	..	..	..	7	..	..	..	82	7
Hydraulics and Irrigation Engineering	..	23*	..	..	..	..	..	..	..	..	..	..	..	23	..
Public Health Engineering	..	18*	..	..	..	..	..	..	..	..	..	..	..	18	..
Structural Engineering and Soil Mechanics	..	24	..	..	..	..	..	23	10	..	..	..	..	47	10
Design and manufacture of Electrical machinery.	..	15	..	..	..	..	..	..	..	..	..	..	..	15*	..
Automobile Engineering	..	15*	..	..	..	..	..	..	..	..	..	..	..	15*	..
Production Engineering	..	18*	..	..	..	..	..	..	..	..	..	..	..	18*	..
Power Plant Engineering	..	15*	..	..	..	..	..	..	..	..	..	..	..	15*	..
Traction and Mechanical Transport Engineering	..	12	..	..	..	..	..	..	..	..	..	..	..	12	..
Fules and Combustion Engineering and Fuel Technology.	..	10	..	..	..	..	..	20	..	..	..	..	10	20	..
Architecture	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Internal Combustion Engineering	..	12*	..	..	..	..	..	..	..	..	..	..	..	12	..
Sound Engineering	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Navigation Engineering	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Power Engineering	..	23*	..	..	..	..	..	..	..	..	..	..	..	23*	..
Sugar Engineering	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

*Represent specialist courses of study in the Engineering Colleges.

STATEMENT IV—*contd.*

Subject	Southern Zone (a)	Southern Zone (b)	Southern Zone (c)	Western Zone (a)	Western Zone (b)	Western Zone (c)	Northern Zone (a)	Northern Zone (b)	Northern Zone (c)	Eastern Zone (a)	Eastern Zone (b)	Eastern Zone (c)	Total (a)	Total (b)	Total (c)
Technology															
Industrial Chemistry and Chemical Technology.	..	27	..	..	..	..	..	26	34	..	..	..	34	53	..
Technology of Soaps, Oils and Fats	..	..	24	..	8	6	..	8	..	..	..	7	..	16	37
Heavy Chemicals	..	..	6@	..	..	..	..	10	..	..	..	..	..	10	6
Textile Chemistry	..	..	6@	..	15	..	..	8	..	..	..	..	..	23	6
Pharmaceuticals and Fine Chemicals	..	..	..	..	8	4	..	..	..	..	..	..	..	8	4
Chemistry of Foods and Drugs	4	..	..	..	8	..	..	..	..	..	..	..	4	8	..
Fermentation Technology	..	..	16@	..	..	..	..	..	..	..	..	..	..	..	16
Plastics, Paints and Varnishes	..	..	..	..	8	8	..	..	..	..	..	7	..	8	15
Electroplating	..	..	..	..	..	6	..	..	..	..	..	..	..	..	6
Intermediates and Dyes	..	..	..	..	8	..	..	..	..	..	..	..	..	8	..
Sugar Technology	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chemical Technical analysis	..	..	2	..	..	6	..	..	..	..	..	..	..	..	8
Ceramics Technology	..	..	..	..	..	..	8	38	10	..	..	7	8	38	17
Paper Technology	..	..	..	..	..	..	..	..	..	..	..	7	..	..	7
Glass Technology	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cellulose Technology	..	..	..	..	8	..	..	..	..	..	..	..	..	8	..
Textile Technology	..	44	..	..	67	..	..	20	..	..	8 (Art) 38 (cotton) 15 (Silk) 8 (Wool)	77	..	169 5 (silk) 8 (wool) 8 (Art fibre)	77 (cotton)
Leather Technology	..	23	..	..	..	..	..	..	..	..	..	15	..	23	15
Applied Physics	10	15	..	..	..	..	..	..	..	20	..	..	30	15	..
Printing Technology	..	..	..	..	..	..	..	..	..	..	..	7	..	..	7
Fruit Technology	..	..	..	..	..	6	..	..	..	..	..	..	..	..	6
Fisheries Technology	..	..	15	..	..	..	..	..	..	..	..	..	..	..	15
Cosmetics and Perfumes	..	..	..	..	..	4	..	..	..	..	..	..	..	..	4
Cinematography	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..
Applied Geology	..	15	..	..	..	..	..	..	..	..	10	..	..	25	..
Food Technology	..	..	15	..	..	..	..	..	..	..	..	..	..	..	15
Mining	..	..	..	..	..	..	..	6	..	..	20	..	..	26	..
Metallurgy	..	..	..	..	..	..	..	10	..	..	23	..	..	23	..

NOTE

@Represent post-B.Sc. diploma courses in certain technological subjects.

The above statement excludes 620 post-graduates and research workers likely to be produced by the Eastern Higher Technical Institution every year when the institution is fully established. Details of subjectwise apportionment of the trained personnel are not available. The graduates likely to be produced by the institution are, however, included in the State.

The Western Higher Technical Institution also, when fully established will produce about 750 post-graduates and research workers, who are also not included in the statement. But the likely outturn of graduates from the institutions are included in the statement.

The development plans of some of the engineering institutions envisage engineering research also and consequently, there will be provision for a considerable number of research workers, but no details are available of such numbers.

37. To sum up the review of the various development and expansion projects, these may be broadly classified into—

(1) Projects envisaging specialists or post-graduate courses of study and research in engineering and technology; and projects envisaging reorganisation of the existing courses of study and their rationalisation.

(2) Projects envisaging completion of establishment of institutions, which are in a formative stage at present.

(3) Projects envisaging expansion of training and research facilities in institutions where these are below par or where there is scope for such expansion.

(4) Projects envisaging reorganisation of existing polytechnics or junior technical institutions so as to start higher instruction or graduate courses in engineering and technology.

(5) Projects envisaging establishment of new institutions in regions where there is scope for them.

(6) Projects envisaging increase in the intake of students into various courses in existing institutions.

38. The development projects of all the institutions in the country cover one or more of the above (2) and (3) above, do not necessarily envisage increase in the intake of students in the institutions, but as a result of the expanded facilities some more students can be admitted for training. (1) does not result in increase in the intake of students into general engineering courses in the institutions but provides for specialisation. (4), (5) and (6) are specially meant for increasing the outturn of trained students in engineering and technology. In the order of importance, however, (2), (3) and (6) should come first. We have given in Statement III a forecast of the number of engineers and technologists likely to be produced by the institutions, both established and under establishment—during the next 5 years. We have also brought out that, if this number is to be attained, it is essential that all established institutions which are seriously handicapped in the matter of training facilities, should be strengthened and the new institutions which are in a formative stage at present should be fully developed. We have not been able to obtain correct estimates of the requirements separately in this respect from all the institutions, which are, however, included in the total financial implications of the development plans undertaken by them.

39. Projects belonging to groups 1, 4 and 5 should be considered as an integral part of a common co-ordinated plan for the development of engineering and technological education in the country as a whole; and such a plan has to be evolved in the light of our assessment for trained personnel for the whole country. The need for the establishment of additional engineering institutions and reorganisation of existing polytechnics or junior technical institutions, so as to provide degree courses in engineering and technology, will, therefore have to be considered in the light of our requirements.

40. Special consideration should be given to projects which envisage specialist or post-graduate study and research in engineering and technology. We have already stated earlier that in the engineering institutions in the country at present there is hardly any specialisation in any of the branches of engineering, either at the graduate or post-graduate stages. This state of affairs is unsatisfactory in as much as there is a great shortage of specialists in the country, especially in the engineering field. These shortages will be more keenly felt in the coming years when the various industrial development projects have to be carried out. An estimate of our requirements in this respect is presented in the sections on 'industry' and 'Government Departments' of this report. It is, therefore, necessary that all first-grade engineering and technological institutions in the country should be re-oriented in such a way that each institution provides for one or more specialised course. But it is equally necessary that as far as possible no two institutions in the same area or zone overlap or duplicate in this regard; and our limited resources are used to the best advantage by developing each institution for the subject or subjects for which it is best suited. For instance, it would be wasteful if every engineering

college in the country plans for specialised courses in irrigation engineering or hydroelectric or power engineering or communication engineering just because there should be diversity of training. Diversity of training should be governed chiefly by the need for it and the resources with which to carry it out. Research development also follows the same principles, although a certain amount of academic freedom should be allowed to each institution to develop research according to its own genius.

Scientific Education and Research

Basic Scientific Education

41. A large number of institutions more or less evenly distributed over the four zones provide facilities for basic scientific education upto the I.Sc., B.Sc., and B.Sc. (Hons.) standards in Physics, Chemistry, Mathematics, Botany, Zoology, Geology and other Biological Sciences. Excepting the Universities of Agra, Lucknow and Allahabad all the other universities conduct intermediate examination in science. B.Sc. examination is conducted by all the 21 universities. It is to be noted the B.Sc. (Hons.) course is of three years' duration in certain universities while in others it is only of two years' duration.

42. The present annual outturn, *i.e.*, in 1947 of I.Sc.'s, B.Sc. and B.Sc. (Hons.) graduates is given below zone-wise:

Statement V

Category	Southern Zone	Western Zone	Eastern Zone	Northern Zone	Total
Intermediates in Science . . .	9,216	2,990	4,923	2,530	19,660
Bachelors of Science . . .	1,740	900	972	1,180	4,792
Bachelors of Science (Honours) in—					
Physics	83*	40	48	23	194
Chemistry	55*	339	112	28	534
Mathematics (Pure and Applied)	45*	14	32	4	95
Geology	27*	6*	22	2	
Botany	27*	13	13		
Zoology (*3 year Hons. Course).	33*	18	7	9 @	67
Microbiology		76			76
Statistics			5		5
Geography			2	1	3
Physiology			15		15

@ Benares Hindu University also produced in 1947, B.Sc. (Hons.) graduates but in what subjects is not known.

In the output of I.Sc.'s shown under Western Zone have been included 1,070 candidates passing the examinations conducted by the Boards of Higher Secondary and Intermediate Education of U.P. & Ajmer & Mewar, and 850 I.Sc.'s which is about 50% of total outturn from the Punjab University in pre-partition year as approximately representing the present outturn from East Punjab, the figure from the East Punjab University not being available.

43. Almost all the institutions teaching upto I.Sc. and B.Sc. standards are working at full strength at present, some in two shifts and no appreciable increase in the outturn of science graduates and intermediates in science can be expected from them in the near future. Any appreciable increase in the output, if necessary, will have to be brought about mainly by opening new institutions as it is understood that the introduction of double shift system in institutions where it has not been introduced already can only be possible by effecting all-round expansion of the institutions concerned, *i.e.* by providing additional staff, equipment and buildings which may practically amount to starting new additional institutions. Even in many of the existing institutions, it has been observed that the facilities available are far from satisfactory. Although the intake of students into various courses in these institutions has increased in recent years there has been no corresponding increase in the staff or equipment or accommodation. Class rooms are generally crowded, the staff over-worked and neither are new equipment added, nor the old and worn-out ones replaced. It hardly needs any stressing here that if basic scientific education in the country is to be maintained at the requisite standard, all these deficencies

should be first removed. There is need for more than passing reference to the conditions in which teachers are working in these institutions. Although in some of these institutions, some facilities for research are available the staff is so heavily burdened with routine teaching—25 hours per five-day week or more—that they find little time for research. The condition is much the same in colleges which provide Honours and Post-graduate courses in addition to undergraduate courses. The salaries of the staff are very low indeed. Discontent prevails amongst the staff and the institutions have been finding it increasingly difficult to attract qualified teachers.

Higher Scientific Education and Research

44. Although Research is intended to be covered separately according to the terms of reference of the Scientific Manpower Committee, we find it necessary to link them together. Higher scientific education and research go hand in hand and it is precisely this unity between educational and research work which distinguishes universities from other educational institutions and in India, higher scientific education is primarily the responsibility of the universities. The university is a sort of organic combination of educational and research institution. There are 21 universities in the country at present distributed zone-wise as follows:

Southern Zone

Annamalai University
Mysore University
Andhra University
Madras University
Travancore University.

Western Zone

Bombay University
Nagpur University
Saugar University
Maharastra University.

Eastern Zone

Calcutta University
Patna University
Utkal University
Gauhati University.

Northern Zone

Allahabad University
Agra University.
Benares University
Aligarh University
East Punjab University
Rajputana University
Lucknow University
Delhi University.

Of the above, Saugar University started functioning only recently and the Universities of Gauhati Maharastra and Rajputana are yet to hold their first examinations. With the exception of the Agra University which is only an affiliating university, all the other universities are maintaining post-graduate departments for higher scientific education and research. There are at the same time a number of institutions not belonging to any university, but affiliated to it, which provides facilities for higher scientific education and research.

45. In the following is given a brief analytical statement on the post-graduate science departments of universities and the first-grade science institutions with particular reference to the nature and scope of activities, the present annual outturn of trained personnel etc. As far as possible the total number of research workers for whom provision exists in each institution is also indicated in the statement.

STATEMENT VI

Institution. 1	Nature and scope of activities 2	Average annual outturn of students with Hons. and post graduate degrees 3	No. of whole-time research workers for whom facilities are available (the figures are Approximate) 4	Remarks 5
Southern Zone				
Madras University				
Biochemistry Deptt. .	Post-graduate research in biochemistry and allied fields with special reference to chemistry of proteins and metabolism, nutrition; industrial application of proteins and carbohydrates; industrial fermentations; vitamin synthesis; pectins and enzymes.	M.Sc. Ph.D. D.Sc. 4	12	One of the best research laboratories for biochemistry. Position in respect of equipment and buildings is good. But the bottleneck is lack of adequate permanent staff.
Zoolog y Department .	Post-graduate research in zoology with special reference to marine biology—fishes, plankton, mollusca, etc.	M.Sc. Ph.D. D.Sc. 3 . .	12	Position in respect of equipment and buildings is not unsatisfactory although it could be better. Lack of permanent staff. is a bottleneck.
Botany Department .	Research in botany with special reference to algealogy, plant pathology and physiology—soil microbiology.	M.Sc. Ph.D. D.Sc. 3 . .	..	Position in respect of equipment and buildings is good. Lack of permanent staff is a bottleneck.
Department of Mathematics.	Post-graduate teaching and research in mathematics—pure and applied—with special reference to topology, algebra, analysis, arithmetical functions and geometry.	M.Sc. Ph.D. D.Sc. 2 . . 3 during 1938/46.	2	Staff is inadequate.
Department of Statistics.	Post-graduate teaching and research in statistics conducts 1 year post-graduate course in statistics.	M.Sc.—2 during 1941/46. Diploma—30 per year.	1	Position in respect of staff and equipment is very bad.
Mysore Universities				
Central College, Bangalore				
Department of Chemistry.	Teaching for B.Sc. (Hons.) and M.Sc. degrees (by ex.) Post-graduate research in colloids and plant chemistry.	B.Sc.(Hons.) . 15 M.Sc. . . 6 D.Sc. . . 3 during the last 10 years.	4	The existing facilities are adequate for teaching in general chemistry, organic chemistry and colloid chemistry; but inadequate for research.
Department of Physics	Teaching for B.Sc. (Hons.) and M.Sc. degrees. Post-graduate research in spectroscopy, X-rays and atmospheric electricity.	B.Sc. (Hons.) . 12 M.Sc. . . 8 D.Sc. . . 1 in the last 10 years.	3	The existing facilities are adequate for teaching in physics with special reference to spectroscopy, X-rays and wireless; but inadequate for research.

Southern Zone—contd.

1	2	3	4	5
Department of Mathematics.	Teaching for B.Sc. (Hons.) and M.Sc. by ex. and research with special reference to theory of elementary mechanics and relativity, algebra and group theory and mycology.	B.Sc. (Hons.) . 10 M.Sc. . . 2 D.Sc. . . 2 during the last ten years.	2	Adequate facilities.
Department of Botany	Teaching for B.Sc. (Hons.) and M.Sc. by ex. and research with special reference to morphology, anatomy, systematics, cytology and mycology.	B.Sc. (Hons.). 8 M.Sc. . { 3 2 D.Sc. . . 2 during the last 10 years.	3	Adequate facilities for teaching but inadequate for research.
Department of Zoology	Teaching for B.Sc. (Hons.) and M.Sc. degree by ex. and research with special reference to cytology, cytogenetics, entomology, protozoology, embryology, parasitology, fresh water biology and animal physiology.	B.Sc. (Hons.) 10 M.Sc. . { 3 1 D.Sc. . . 2 during the last 10 years.	3	Adequate facilities for teaching but inadequate for research.
Department of Geology	Teaching for B.Sc. (Hons.) & M.Sc. degrees by examn. and research with special reference to crystallography Mineralogy, petrology, stratigraphy and palaeontology.	B.Sc. (Hons.) 10 M. Sc. { 4 2	2	Facilities adequate for teaching but inadequate for research.
Travancore University :				
University, College, Trivandrum.	Teaching for B.Sc. (Hons.) in mathematics and M. Sc. degree by ex. in physics, chemistry and Mathematics. Research in all the above subjects.	B.Sc. (Hons in Math) —15 per year. M. Sc. Physics—6 Chemistry—4	Physics . 3 Chemistry . 2 Botany . 2 Zoology . . 2 Maths. . 3	Staff, equipment and accommodation are inadequate both for teaching and research.
	Physics.—Scattering of light and molecular structure, supersonics, X-ray analysis of crystals,, radio-activity and magnetic survey.	*Ph. D.* Physics during the last ten years.		
	Chemistry.—Chemistry of plant products and rare earths.			
	Zoology.—Invertebrate embryology, anthropod embryology and entomology of insect pests.			
	Botany.—Plant hybridisation chromosomes, morophology and anatomy of ayurvedic drugs.			
	Mathematics.—Modern geometry, differential geometry, algebra, mathematical physics, statistics and vector analysis.			

Southern Zone—contd.

1	2	3	4	5
Andhra University.				
	Teaching and research in physics, applied physics, mathematical physics, chemistry, chemical technology, geology, botany and zoology. *Teaching.*—B.Sc. (Hons.) in all the above subjects—M. Sc. by examination in applied physics, chemistry of foods, drugs and water analysis ; chemical technology, (sugar, pharmaceuticals and drugs, chemical engineering).	B.Sc. (Hons)—80 per year. *M.Sc.*— Applied physics 8 per year. Foods & Drugs . 6 Glass & Ceramics 1 Chemical Technology . 1	Physics . . 10 Chemistry . 8 Math. . . 3 Geology . . 6 Zoology . 3	The Departments of Botany, Zoology and Geologyare in a formative stage. The important feature of the university is teaching upto B. Sc. (Hons.) and M. Sc. stages in chemical technology and applied physics.
	Post-graduate research.—Physics spectroscopy, atmospherics, wireless, crystal physics, Raman Effect, ultrasonics and micro-waves.	*M.Sc.*— Physics . . 6 per year. Chemistry—2 per year Math. (applied) 2 Zoology . 2 per year. Geology . 6 per year.		Equipment is adequate. for teaching but inadequate for research Accommodation is generally adequate, accommodation for lecturers should be increased.
	Chemistry.—Plant chemistry and plant products, drugs and insecticides, synthetic organic chemistry, photochemistry, analytical chemistry and ceramics. *Technology.*—Sugar and by-products, utilization of Indian vegetable products, high pressure reactions and Indian drugs. *Applied Physics.*—Technical optics, permanent magnets, alloys and metallurgy. *Zoology.*—Marine biology and fisheries. *Botany.*—Cytology, Plant physiology, Morphology of plants, Fungal pests of plants. *Geology.*—Rock formations with special reference to limestones of palnad : palaeontology ; charnochites, khondalities , and chromite deposits of Bezwada area. *Mathematics.*—Theory of functions, zeta-function of Riemann, configuration of spaces ; mathematical aspects of monopoly and imperfect competition. *Mathematical Physics.*—Raman spectra aerodynamics and its application (theoretical).	*Ph. D. & D. Sc.*— (Total for the last 10 years). Physics . 10 Chemistry . 11		

1	2	3	4	5
Annamalai University.				
Faculty of Science .	Teaching in mathematics, physics, chemistry and zoology upto B. Sc. (Hons.) stage. Post-graduate research in physics, chemistry, mathematics, botany and zoology is intended but precious little work is being done at present. However, the following indicates the lines of work engaged in occasionally. *Chemistry.*—reaction kinetics *and* synthetic organic chemistry. *Physics.*—diamagnetism of crystals ; scattering effect in x-ray discharges and study of atmospheric F : *Zoology.*—Embryological aspects of insects, mollusca fish. *Botany.*—Cytology with special reference to relationship between chromosomes and morphology, cytotaxonomy and hybridization and cytogenetics.	*B. Sc. (Hons.)*— Chemistry 8/yrs. Physics . . 10 Zoology . . 3 Math. No information *M. Sc.*— Chemistry . 1 year Physics . 1 year *Ph. D., D. Sc.* (Total for the last 10 yrs.) Physics . . 2 yrs. Math. . . 2 yrs. Botany . . 2 yrs. Zoology . 1 yr.	Provision exists for two research workers at a time in each of the branches.	Accommodation is adequate for teaching and research. Staff and equipment are very poor for research which is consequently in a sad state of development.
Presidency College, Madras	Teaching upto B.Sc. (Hons.) in Physics, Chemistry, Botany, Zoology and Geology. Research in all the above subjects is intended but is being carried out only sporadically	*B.Sc. (Hons.)*— Physics . 10 Chemistry . 14 Botany . 7 Zoology 7 Geology 8 *M.Sc.*— Physics . 1 Chemistry . 2 *Ph. D. & D. Sc.*— (Total for the last 10 years) Chemistry . 2	Physics . 2 Chemistry . 3	The available facilities are adequate for teaching upto B.Sc. (Hons). Research facilities are generally limited. They are somewhat good for research in dyestuffs and electro-chemistry.
Christian College, Madras	Teaching upto B.Sc. (Hons.) in mathematics, physics, chemistry, botany and zoology. Research in all the above subjects is intended but is being carried out on a restricted scale. *Chemistry*—Reaction of kinetics, dielectric constants of solvents, substantivity of dyes, kinetics of diazo-coupling reactions. *Physics.*—Photo-elastic measurements. *Botany*—Cytological problems. *Zoology*—Morphological work in entomology, embryological work in vertebrata.	*B.Sc. (Hons.) or B.A. (Hons.)*— Physics . 7 Chemistry . 10 Zoology . 4 Math. . 7 *M.Sc.*— Chemistry . 1 Math. . 1	Chemistry . . 2 Physics . . 1	The available facilities appear to be adequate for teaching upto B.Sc. (Hons.) standard.

Southern Zone—contd.

1	2	3	4	5
Maharaja's College, Ernakulam, Cochin.	Teaching upto the B.Sc. (Hons.) standard in chemistry at present. Post-graduate teaching upto the diploma standard in pharmaceuticals and fine chemicals and soaps, oils and fats. Post-graduate research is intended in all branches of science but it is at present being conducted only in *chemistry*—organic chemistry with particular reference to synthetic drugs, active principles of plant products, constitution of essential oils, constitution of glycerides and absorption by synthetic fibres.	*B.Sc. (Hons.)*— Chemistry . 8 per year *Post-graduate diplomas*— Pharmaceuticals and Drugs 6/yr. Soaps, Oils and Fats 6/yr.	Provision exists for 6 research workers in chemistry	Equipment adequate for teaching upto B.Sc. (Hons.) standard in Chemistry and upto B. Sc. in the rest. The technological laboratories are fairly well-equipped for post-graduate teaching in pharmaceuticals and drugs and soaps, oils and fats. Accommodation is satisfactory. The strength of the staff is adequate but the salaries are very low. The bottleneck for research development is lack of suitable fellowships.

Eastern Zone

There are 4 universities in this zone of which the Gauhati University has just started functioning. Facilities for higher scientific education and research are provided in the post-graduate departments of the universities as well as in a considerable number of science institutions. Full particulars of all such institutions have not been collected but the following summarises whatever information is available regarding some of them.

1	2	3	4	5
Calcutta University, Post-graduate Science Departments	Post-graduate teaching in physics, chemistry, botany, geology, zoology, physiology, biochemistry, geography, statistics, psychology and research in all the above subjects and with particular refeence to spectroscopy, nuclearphysics, cosmic rays, X-ray and crystallography, electronics, bio-physics, vacuum technique, biochemistry, microchemistry, inorganic chemistry, organic and physical chemistry, applied psychology and zoology.	*M. Sc.*— Physics . 23 Chemistry . 12 Botany . 13 Zoology . 12 Physiology . 4 Geology . 9 Geography . 13 Statistics . 13	Physics . 20 Chemistry . 12 Botany . 8 Zoology . 4 Physiology . 4 Geology . 2 Geography . 2 Statistics . 2	Equipment and accommodation adequate. Staff inadequate especially in respect of research
Presidency College, Calcutta	Post-graduate teaching in physics, chemistry, botany, physiology, geology and research in all the above subjects.	*M.Sc.*— Physics . 4 Chemistry . 8 Mathemat. . 2 Botany . 2 Physiology . 3 Geology . 9 *Ph. D., D.Sc., etc.*— (Total for the last 10 years) Chemistry	No information	

Eastern Zone—contd.

1	2	3	4	5
Science College, Patna	Post-graduate teaching in physics, chemistry, and mathematics and research in all these subjects. No details regarding field of research.	*M. Sc.*— Physics : 12 Chemistry : 12 Math. : 23 *Ph.D., D.Sc., etc.*— (Total for the last 10 years). Chemistry : 4 Physics : 2	Physics : 3 Chemistry : 3 Math. : 2	Staff inadequate, equipment only for teaching but inadequate for research ; accommodation satisfactory.
Ravenshaw College, Cuttack.	Teaching upto B.Sc. (Hons.) in physics, chemistry, mathematics, botany and zoology ; post-graduate teaching in chemistry and mathematics. Research in all the above science subjects. No details regarding field of research.	No information.	No information.	

Western Zone

1	2	3	4	5
University of Saugor.	Teaching upto M.Sc. standard in physics, chemistry, mathematics, botany, zoology and geology ; Research in all these subjects and with special reference to X-rays in physics, colloids in chemistry, marine biology and applied entomology in zoology.	*M.Sc.*— Physics : 4 Chemistry : 8 Botany : 2 Zoology : 2 Geology : 3	No information.	
Gujrat College, Ahmedabad.	Teaching upto M.Sc. standard in physics, chemistry, botany and mathematics and research in all these subjects. *Physics.*—Optical and electrical properties of metals and metalic firms ; cloud formation and passage applied through clouds ; atmospheric pollution of air, industrial dusts and smokes.	*M.Sc.*— Physics : Nil Chemistry : 1 Botany : 2		
Robertson College, Jubbulpore.	It appears that teachng upto M.Sc. standard has only been started this year or is contemplated.			
Baroda College, Baroda	Teaching upto M.Sc. standard in physics, chemistry and botany. Research in all these subjects is intended but no details are available at this stage.	*M.Sc.*— Physics : 2 Chemistry : 2 Botany : 1	No information.	
College of Science, Nagpur University.	Teaching upto M.Sc. standard in physics, chemistry, botany, zoology and mathematics. Research is intended in all these subjects but no details are available.	*M.Sc.*— Physics : 2 Chemistry : 5 Botany : 3 Zoology : 1 Math. Pure : 9 Math. Applied : 3 *Ph.D.*— Chemistry : 2 Botany : 6 (duringthe last 6 years or so).	No information.	

Western Zone—contd.

(1)	(2)	(3)	(4)	(5)
Fergusson College, Poona.	Teaching upto M.Sc. standard in Physics, Chemistry, botany, zoology and mathematics. Research in all these subjects is intended but no details are available.	*M.Sc.*— Physics : 5 Chemistry : 6 Botany : 2 Zoology : 1 Geology : 2 Math. : 6	No information.	
Karnatak College, Dharwar.	Teaching upto M.Sc. standard in physics, chemistry, botany and zoology.	*M.Sc.*— Physics : 16 Chemistry : 12 Botany : 2 Zoology : 4	Do.	
Royal Institute of Science, Bombay.	Teaching upto M.Sc. standard in chemistry, physics, botany, zoology and mathematics. Research in all these subjects but no details are available.	*M.Sc.*— Physics : 4 Chemistry : 11 Botany : 3 Zoology 3 Math. : 5	Do.	
St. Xavier's College, Bombay.	Teaching upto M.Sc. standard in chemistry, botany, zoology and mathematics.	*M.Sc.*— Chemistry : 6 Botany : 2 Zoology : 4 Maths. : 3		
Department of Chemical Technology, University of Bombay.	Teaching upto M.Sc. standard in chemistry and chemical technology courses. Research in chemistry and chemical technology.	*M.Sc. in*— Chemistry : 50 *Ph. D. in* Chemistry : 2 Chemical Technology : 3 (For outturn in Technology courses please see under Engineering and Technological Education).	Do	

Northern Zone

(1)	(2)	(3)	(4)	(5)
Benares Hindu University, College of Science.	Teaching upto M.Sc. standard in physics, chemistry, mathematics, botany, zoology and geology and research in all these subjects.	*M.Sc.*— Physics : 12 Chemistry : 8 Zoology : 2 Botany : 3 Geology : 12	No information.	
	Physics.—Positive rays, light emission, foucoult rotation, cosmic rays, spectroscopy, Xrays, wireless, Doppler effect, molecular structure and atmospheric electricity.	*Ph. D., D. Sc., etc.*—(during the last 10 years).		
	Chemistry.—Reaction under high tension electric discharge , Joshi effect, electrochemical preparaton and electro-deposition, manufacture of fine chemicals, colloids and pharmaceutics reactions.	Physics : 2 Chemistry : 6 Zoology : 3 Botany : 2 Geology : 1		
	Zoology.—Invertebrate zoology, vertebrate zoology and fisheries.			
	Geology.—Historical geology and palaeontology.			

1	2	3	4	5
Delhi University, Post-graduate Departments of Science.	Teaching upto B.Sc. (Hons.) and M.Sc. standards in physics, chemistry, mathematics and zoology and research in all the above subjects. *Physics.*—Cosmic rays, advanced quantum mechanics, statistical thermodynamics. *Chemistry.*—Plant products, colloids, dyestuffs, soil sciences.	*B.Sc. (Hons.)*— Chemistry : 25 Physics : 18 *M.Sc.*— Chemistry : 10 Physics : 17	No information.	B.Sc. (Hons.) in botany has just been started with an intake of 30 students.
Lucknow University, Post-graduate Departments of Science	Teaching upto B.Sc. (Hons.) standards in physics, chemistry, mathematics, botany, zoology and geology and research in all the above subjects. *Physics.*—Electronics, spectroscopy, Raman effect, X-rays and X-rays defraction, molecular structure and nuclear physics. *Chemistry.*—Colloids surface Chemistry, supersaturation photo Chemistry, and synthelic and organic Chemistry. *Botany.*—Palaebotany, morphology, mycology and plant pathology, plant physiology and embryology. *Zoology.*—Helminthology, fishes, insects, reptiles and embryology.	*B.Sc. (Hons.)*— Physics : 3 Chemistry : 2 Geology : 2 Maths. : 3 *M.Sc.*— Physics : 16 Chemistry : 15 Botany : 6 Zoology : 7 Maths. : 6 *Ph.D., D.Sc., etc.*— (during the last 10 years). Physics : 2 Chemistry : 6 Zoology : 9	Do.	
Allahabad University, Post-Graduage Departments.	Teaching upto M.Sc. standard in Mathematics, physics, chemistry, zoology, agricultural zoology, botany and agricultural botany. Research in all the above subjects. *Physics.*—Spectroscopy, Light scattering, wireless and X-rays. *Cemistry.*—No details. *Mathematics.*—Real and complex variables, Fourier and allied series, hydrodynamics, astronomy and fluid-dynamics. *Botany.*—Plant physiology, micology and plant pathology. *Zoology.*—Entomology, helminthology, cytology and fishes.	*M.Sc.*— Mathematics : 9 Physics : 13 Chemistry : 17 Zoology : 6 Agricultural Zoology : 4 Botany : 4 *Ph.D., D.Sc., etc.*— Physics : 10 Chemistry : 23 Mathematics : 8 Botany : 7 Zoology : 16		

1	2	3	4	5
Aligarh Muslim University, Post-graduate Departments.	Teaching upto B.Sc. (Hons.) and M.Sc. standards in physics, chemistry, mathematics, botany, zoology and geography. Research in all the above subjects.	*B.Sc. (Hons.)*— Geography : 1 Mathematics: 1 Physics : 2 Chemistry : 1 Zoology : 9		
	Physics.—Absorption spectra and emission spectra of molecules, X-rays, micro-wave propogation, reflection and absorption co-efficient, therionic work functions, elastic and piezo-elastic properties of crystals.	*M.Sc.*— Geography : 1 Physics : 9 Chemistry : 17 Botany : 8 Zoology : 3		
	Chemistry.—Synthetic hydrocarbons, azodyes poly basic acids, plant products-glucosides, provitamins. ,	*Ph.D., D.Sc. etc.*— (For the last 10 years) Physics : 14 Chemistry : 7 Mathematics : 1 Zoology : 3 Botany : 1		
	Mathematics.—Ferio functions of complex variables, mathematical statistics.			
	Zoology.—Helminthology and entomology.			
	Geography.—Regional geographny, economic geography, physical geography, political geography, cartography, bio-grography, anghropogeography, historical geography, city study and land utilization.			
Agra University .	It is only an affiliating University and does not maintain any post-graduate research departments. The outturn from this University is as follows :—	*M.Sc.*— Mathematics : 16 Physics : 6 Botany : 8 Chemistry : 26 Zoology : 14		
East Punjab University, Post-graduate Departments.	The East Punjab University Post-Graduate Departments in physics, chemistry, botany and zoology are in a formative stage. The latest outturn of M.Sc.s. from this university is as follows :—	*M.Sc.*— Physics : 8 Chemistry : 11 Botany : 1 Zoology : 4 *M.Sc. (Tech.)*— Chemistry : 17		

Southern Zone

46. From the above analysis of Higher Scientific Institutions it will be observed that B.Sc. (Hons.) course is of three year's duration in some of the universities in this zone; honours courses are provided in all the science subjects in some of the institutions and in others only in a few. It is, however, understood that the latter institutions too intend expanding their scope shortly.

47. M.Sc. degree is obtainable mainly through research in the Universities of Madras and Annamalai while in the other three universities this is obtained either by research or by examination or by both. The Madras University maintains well-equipped post-graduate research departments for Bio-chemistry, Botany, Zoology and Mathematics. Facilities for teaching up to M.Sc. standard in Physics, Chemistry, Mathematics, Botany, Zoology and Geology are provided in the science colleges of the Universities of Mysore and Andhra. The course is confined to Physics and Chemistry only in the Travancore University College at present.

48. An important feature of the Andhra University Science College is its facilities for B.Sc. (Hons. and M.Sc. courses in Chemical Technology and Applied Physics. The branches covered in chemica technology are sugar, pharmaceuticals and drugs and chemical engineering. We have referred to these courses in detail under 'Engineering and Technological Education'. We have also referred in the same section to the post-graduate diploma course in 'Phamaceuticals and Drugs' and 'Soaps, Oils and Fats' provided in the Maharaja's College, Ernakulam. Except these two instances, no other university in the zone provides for technological or applied science courses either in its science departments or in its constituent colleges. Madras and Annamalai Universities have, however, started technolgogical colleges for certain subjects and we have referred to these institutions in detail under 'Engineering and Technological Education.' There being a shortage of technically trained personnel in the country, especially in chemical technology and other applied sciences, the present position calls for suitable reorientation of Higher Scientific Education with a view to providing for courses in these subjects in the university science departments and first-grade science colleges.

49. Research development in the Southern Zone has been satisfactory in certain institutions and quite the contrary in others. Though it is desirable that every first-grade science college should also be a strong centre of research, it is found that most of the colleges in the zone have shown little progress in research development. There are many reasons for this state of affairs such as the lack of qualified staff to guide research, the lack of equipment and research fellowships or sholarships to attract scholars and the lack of sufficient time for the members of the staff to engage in research. The last is the most common complaint that has been made to us during our survey. We understand that even though facilities for research are available in certain institutions, the staff is so heavily burdened with routine teaching that few find sufficient time or are left with sufficient energy to carry out researches. Whatever research is carried out in the colleges is sporadic and uncoordinated. This state of affairs is also noticed in at least one university even though it has a Faculty of Science in all the science subjects and M.Sc. is obtainable by research only. Some of the departments in this particular university do not even have Professors and are being managed by lecturers who are only qualified to carry out routine teaching upto the B.Sc. standard. It is not necessary to dilate in detail on the present state of research activities generally in most the educational instituions and suffice it to say that it is in a sorry plight. There are, of course exceptions which will be referred to in detail in the following.

50. All the three post-graduate departments—Bio-chemistry, Botany and Zoology—of the Madras University are active centres of research in their respective fields. The Bio-chemistry Department specialises in the chemistry of proteins and metabolism, nutrition, industrial application of proteins and carbohydrates, industrial fermentation, vitamin synthesis, pectins and enzymes. The special fields of investigation in the Botany Department are algælogy, plant pahtology and physiology and soil microbiology. It is to be noted that, although bio-chemical research has been well developed in the Madras University, research in other branches of chemistry—inorganic, organic and physical—has not received sufficient attention. All the three laboratories of the university are well-equipped and the accommodation position is satisfactory for the present. But lack of permanent research staff has been the handicap. For instance, the permanent staff of the Bio-chemistry Laboratory consists of

a Director and one research assistant who carry out the entire work of the laboratory is carried out. This is unsatisfactory and will definitely deter the progress of research. The laboratory serves a dozen research students or more and there should consequently be a larger permanent staff. The same is the case with other research departments of the university.

51. The College of Science and Technology of the Andhra University is fast developing into an active centre of research in Physics, Chemistry, Geology, Chemical Technology and Mathematics. Research activity in Zoology and Botany, is new. In *Phisics*, spectroscopy, atmospherics and wireless, cryastal physics, Raman Effect, ultrasonics and microwaves are studied. Plant chemistry, synthetic organic chemistry and analytical chemistry are the special fields of research of the Chemistry Division. Technological research in the university comprises investigations on problems of sugar industry, utilisation of Indian vegetable products, high pressure reactions, Indian drugs and technical optics. Research in *Mathematics* and *Mathematical Physics* relates to the theory of functions, zeta function of Rieman, configuration of space and mathematical aspect of monopoly and imperfect competition. Geological research has been just organised with special reference to the rock formations of the limestones of the Andhra region, palæontology, charnochites, khondolites, and the chromite deposits of the Bezwada area. The accommodation and staff facilities are adequate in all the research departments but equipments fall short of the requirements.

52. The Central Research Institute of the University of Travancore is a whole-time research organisation under the auspices of the Council of Research, Travancore and the Travancore University and is developing into an important research centre in the fields of Applied Biology, Applied Chemisrty, Marine Biology and Fisheries, and Mineral Survey. The research programme of the Institution is directed towards applied and industrial problems. The Institute also conducts in its Department of Statistics, a two-year post-graduate course in statistics, leading to M.Sc. degree. The laboratories of the Institute are only moderately equipped and have few specialised equipment and apparatus. The accommodation position is very unsatisfactory due to which the available facilities, it is understood, are not being made use of fully for the training of more research workers which would otherwise have been possible.

53. Of the several colleges which have to some extent facilities for research, mention must be made of the Central College in Bangalore, the Presidency College, Madras, Maharaja's College, Ernakulam and the University College, Trivandrum. The lines of research in all these colleges are indicated in column 2 of the analytical statement V. In the Central College, Bangalore, the special lines of research are spectroscopy and X rays in Physics; quantum mechanics and theory of elementary particle of Matehmatics; colloids and plant chemistry in *Chemistry*; anatomy, systematics, morphology and Botany; animal physiology, embryology and cyto-genetics in Zoology; and crystallography, minerology, petrology and palæntology in *Geology*. Although a fairly vast field of research has been stated to be covered by the Institution,the available facilities are anything but satisfactory. With the rest of the Institutions also, the same is the story.

Western Zone

54. There are 9 institutions in this zone providing facilities for post-graduate education in science subjects. Of these, three are Post-graduate Departments of Universities of Bombay, Nagpur and Saugar and the rest Science Colleges affiliated to these universities. The details of the courses of study in each of the institutions as well as the present annual outturn of students in each course are indicated at statement V. The number of subjects offered for the M.Sc. courses differs from institution to institution but Physics, Chemistry, Botany, Zoology and Mathematics are taught in most of the institutions. The only Post-graduate Department of the Bombay University now functioning is of Chemistry and Chemical Technology. Facilities for geological education are available only in the University of Saugar and the Fergusson College, Poona and the combined outturn of these two institutions is 5 M.Sc. per year.

55. It is very hard to assess the development of research in the zone as details of the nature and scope of research carried out in the various fields by mot of the science institutions are not available. Information is also not available regarding the number of research workers for whom training facilities are available in each institution. But all the institutions in the zone claim to have facilities for reaserch

in the various branches of sciences. However, special mention must be made of the Department of Chemical Technology, University of Bombay which, besides carrying on post-graduate training in chemistry and applied chemistry, offers good facilities for both fundamental and applied research in chemistry. The special fields of research covered by this institution are paints, varnishes and plastics, dyestuffs, pharmaceuticals and fine chemicals, chemical engineering and soaps, oils and fats. It is understood that the department caters for about 50 research workers at a time. In the University of Saugor, research is being organised in X-rays, colloidal chemistry, marine biology and applied entomology.

Northern Zone

56. All the universities, excepting the Agra University, are maintaining post-graduate departments for teaching and research. M. Sc. courses in physics, chemistry, mathematics, botany, and zoology are provided in four Universities. Delhi University has at present organised post-graduate courses only in chemistry and physics. Facilities for post-graduate training in geology are available in only one university, Benares Hindu University. The intake to and outturn from the M.Sc. courses are satisfactory in all the institutions and Statement V gives details of the present outturn from each institution.

57. All the post-graduate departments of universities in the zone have facilities for research. In the Benares Hindu University, physical research covers postitive rays, light emission, Focult rotation, cosmic rays, spectroscopy, X-rays, wireless, Doppler effect and molecular structure and atmospheric electricity. Reaction under high tension discharge, Joshi effect, electro-chemistry and colloids are the special fields of research in chemistry. Research in zoology relates to invertibrate and vertibrate zoology and fisheries. Historical geology and palaentology are the special fields of research in geology. In the Post-graduate Department of Delhi University cosmic rays, advanced quantum mechanics, and statistical thermo-dynamics form the special fields of investigation in physics; and in chemistry, plant products, colloids, chemistry of dyes and soil sciences. Electronics, spectroscopy, Raman effect, X-rays and X-ray defraction, molecular structure and nuclear physics form the special fields of investigation in physics in the Post-graduate Department of the Lucknow University. The most important research development of this university, however, is in botany with special reference to palaeobotany. An Institute of Palaeo-botanical Research has been developed at this University and we shall refer to this Institute in detail at a later stage. Facilities for research in spectroscopy, light scattering, electronics, microwave propagation, molecular spectra are available in the Universities of Allahabad and Aligarh. At the latter, synthetic-hydrocarbons, azodyes, poly-basic acids, plant products and pro-vitamins are covered in chemical research. Helminthology and entomology are the general fields of investigation in zoology at both these universities. Botanical research in these institutions relate to plant physiology, micro-biology and plant pathology.

Eastern Zone

58. Of the four universities in the Eastern Zone, the Gauhati University has just started functioning. In the Calcutta University, facilities for higher scientific education and research in physics, chemistry, botany, zoology, geology, physiology, statistics and geography are available in respective Post-graduate Departments. Excepting in zoology such facilities are also available in the Presidency College, Calcutta, which is affiliated to the Calcutta University. Science College, Patna, which is affiliated to the Patna University offers M.Sc. courses in physics, chemistry and mathematics. Statement V indicates the present outturn of post-graduates from these institutions.

59. From the point of view of research development the University College of Science and Technology, Calcutta is the most important university research centre in this zone. Facilities for post-graduate research over a wide range of subjects are available at this institution and particularly in spectroscopy, nuclear physics, cosmic rays, X-rays and crystallography, electronics, bio-physics and vacuum technique, microchemistry, bio-chemistry, inorganic, organic and physical chemistry and zoology. A Cyclotron Laboratory has been established in this institution for research in nuclear physics. It is understood that these post-graduate departments provide facilities for about 60 research workers at a time in all the important branches of science and technology.

60. Although details regarding the physical and staff facilities available in each individual institution in the four zones have not been stated in the analytical statements, it is understood that generally all the institutions are seriously handicapped in one respect or another—lack of equipment or accommodation or staff. These shortages have, to some extent or other, reflected on the standard of training and research in the institutions. Absence of suitable research fellowships or scholarships in institutions where facilities for research are available and inability of the staff to find sufficient time for research have discouraged the progress of research in many institutions. From a general survey of the conditions obtaining in all the institutions, it has been felt that an impetus to research can only be given if the teaching load on the staff is lessened and the institutions are enable to attract suitable research scholars.

The following statement indicates zone-wise the present annual outturn of post-graduates in the various branches of science.

STATEMENT VI

Present Outturn of Scientific Personnel

Category	Southern Zone	Western Zone	Eastern Zone	Northern Zone	Total year
Master of Science (M.Sc.)	Per year.	Per year.	Per year.	Per year.	
Physics	29	19	31	81	160
Chemistry	26	12	46	104	188
Mathematics (Pure &	11	32	32	31	106
Applied)					37
Botany	9	..	12	35	56
Zoology	10	3	15	40	68
Geology	12	4	9	12	15+
Statistics	8+	..	7	..	30
	Post-graduate 30 Diploma holders.		..		Post-graduate Diploma holders.
Geography			3	1	4
Physiology			8		8
Doctor of Science (Ph.D., D.Sc., etc.)	During 10 years.	During 10 years.		During 10 years.	In 10 Years
Physics	29	..	11	28	68
Chemistry	29	15	30	42	116
Mathematics	5	..	2	9	16
Botany	5	6	3	10	24
Zoology	3	..	1	31	34
Geology	..	..	..	1	1

61. In the preceding paras. we have described in detail the research activities of the various post-graduate departments of universities and science institutions in the country. These represent one aspect of research development. In order to complete the picture of scientific and industrial research in the country, we should consider at this stage the activities of several 'Special Institutions'—special in the sense that these do not ordinarily cater for routine post-graduate training of scholars for higher degrees or diplomas unlike the university institutions but are whole-time research organisations. In the context of higher scientific education however, these 'Special Institutions' have their own importance that many of them function as research training centres and also provide facilities for research students to work for higher post-graduate degrees of universities.

62. A brief analytical statement on these institutions is given in the following Statement indicating the field and scope of research and the provision that exists for the training of research workers.

STATEMENT VII

Special Research Institutions

Institution	Nature and scope of activities	No. of research workers for whom research training facilities are available	Remarks
1	2	3	4
Indian Institute of Science, Bangalore.	*General & Inorganic Chemistry.*—Reactions at high temperatures, absorption and emission spectra, colloidal properties of rubber, ore dressing, electro-chemistry, photo-chemistry, conductivity, fermentation chemistry and microbiology, enzymes, antibiotics and developmental research of an applied character in industrial chemistry, plastics, etc.	Communication Engg. . 7 Internal Combustion Engineering . . 8 Aeronautics . . 2 Organic Chemistry . 20 Bio-chemistry . . 45 General and Inorganic Chemistry . . 30	Research in Metallurgy, internal combustion engineering and power engineering is in a formative stage.
	Bio-chemistry.—Food and nutritional problems, physiological chemistry, soil sciences and plant nutrition, enzyme chemistry, dairy chemistry, sanitation chemistry including water sewage and trade wastes, medical chemistry.	Physics . . . 10 Metallurgy . . 12 Power Engg. and Elect. Technology 20	
	Physics.—Optics, spectroscopy, magnetism, magneto optics, X-rays, electron-difraction, ultra-sonics, physical minerology, crystallography.		
	Aeronautics.—Aero-dynamics, design of wind tunnels, etc.		
	Chemical Engineering.—Design and operation of chemical plants and equipment.		
	Organic Chemistry.—Coal-tar products including dye-organic, chemical operations, unit processes in organic chemical operations, essential oil and resins, synthetic terpenes, synthetic drugs, Indian medicinal plants, theoretical investigations in general organic chemistry, industrial research in organic chemical industry.		
	Metallurgy.—Developmental research bearing on metals and alloys from ores, theoretical investigations such as fatigue in metals, etc.		
	Communication Engineering.—Electronics, wireless propagation, atmospherics, microwave propagation.		
	Power Engineering.—Thermal and hydro-electric generation and transmission, civil mechanical and hydraulic engineering as applied to power engineering, high voltage engineering, etc.		
Solar Physics Laboratory, Kodaikanal.	Research and routine work in theoretical and experimental solar physics. Research activities of the Institute relate to atomic contoures, measurement of the temperature of the sun's disc using the band spectra of CH Molecule, structure of K & H lines, solar corona and magnetism of sun's spots. Routine observations relate spectra-heliographs of the sun's spots, visual observations of the sun's prominences etc. A monthly bulletin of statistical solar calculations is published from the laboratory.	The present facilities are adequate for the training of 7 research workers in astronomy and astrophysics in experimental and 3 in the theoretical.	

1	2	3	4
Nutrition Research Laboratories, Coonoor.	Fundamental research in the science of nutrition and application of basic knowledge to studies in the field. Analysis of natural and processed foods for their nutritive value. Training of nutrition workers.	No details are available regarding the number of research workers who could be trained. It may, however, be taken as 4.	
Laboratories of the Indian Academy of Sciences, Bangalore.	Research in physics, crystallography and minerology.	The laboratories are in a fromative stage at present and will start functioning presently. Provision will exist for 10—12 research workers.	
Central Marine Fisheries Research Institute, Mandapam and Madras.	Research in marine biology and oceanography in the particular reference to sharks, rays, mackerel, sardines, prawns and crabs, edible mollusca, survey and museum work on plankton as fish food and sea flora. Institute will also con-duct a 10 month post-graduate course in marine biology with a view to training personnel for undertaking independent developmental research in the country. The intake into the course is 25 students at a time.	The Institute is in a formative stage.	
Bose Research Institute, Calcutta.	A research institution devoted to "the fuller investigation of the many ever-opening problems of the nascent science which includes both life and non-life, with the application of methods of science to problems of agriculture, industry and medicine". The specialised branches of research carried on are: (*a*) Physics, and biophysics; (*b*) Inorganic, organic and biochemistry; (*c*) Plant physiology, plant breeding and cytogenetics; and (*d*) Microbiology and anthropology. The lines of research of each of the above branches of science are: *Physics*.—Nuclear fissionand distintgration, artificial radio activity, large air showers, production of cosmic ray bursts and penetrating showers in different absorbing media, X-ray difraction method for the study of large molecules of biological origin and of their ploymers; application of spectroscopy for the study of absorption spectra of biological substances and identification and quantitative estimation of elements present as impurities in organic compounds; production of ultrasonics and their application in biology, industy, etc. *Biophysics*:—Properties of natural and artificial membrances, bio-electric potentials, electrophoresis, effect of short-wave radiation and neutrons on living tissues. *Chemistry*.—Study of plant products, their isolation and synthesis, effect of manurial treatment on growth and yield of plants of economic importance, soil and plant tissue analysis, radio chemistry. *Microbiology*.—Study of antibiotic substances, retting fibres and fungal infection of cereals and tropical fruits. *Plant Physiology and Cytogenetics*.— Plant physiology, growth respiration and transmission of excitation.	Physics . . . 3 Chemistry . . . 9 Plant physiology and plant breeding . 2 Microbiology . . 3	The Institute is well equipped for investigations in certain special branches of physics, biophysics, chemistry, botany and, microbiology. There is however, urgent need for equipping the institute with the latest apparatus, etc., for intensive research in all these branches. The laboratory accommodation is inadequate for the present intake of research workers.

1	2	3	4
Indian Association for the Cultivation of Science, Calcutta.	Theorectical and experimental research in physics and chemistry. The lines of research in these two fields are : *Physics*: X-ray and crystal structure, magnetism and light scattering and Raman Effect, flourscence and absorption of light. *Chemistry*: Chemistry of high polymers	Experimental physics . 10 Theoretical Physics . 5 Physical Chemistry . 5	Research in the chemistry of high polymers is in a formative stage. Except for the new lines of research for which equipment facilities will have to be created separately, the available facilities by way of staff, equipment and accommodation are adequate for the rest.
Lac Research Institute, Ranchi.	The Institute is meant for investigations into the improved methods of cultivation, manufacture and utilization of lac and lac products.	The permanent staff of the Research Institute consists of a good number of research officers and research assistants. There is no regular intake of research workers for training. However, it is estimated that about 7 research workers can be trained at a time in the various aspects of research in lac and lac products.	It is a full-time research institution meant for the specific purpose of the Lac Industry and the facilities available by way of staff, equipment and accommodation are satisfactory in all respects. The institution has certain types of specialised equipment for research in lac and allied fields such as for instance plastics. The Institute at the same time conducts training courses in lac cultivation and in the industrial utilization of lac, the former being of one year's duration and the latter of six months. These courses are specially meant for science graduates who are interested in shellac trade. At the end of the course, a certificate is issued by the Institution.
Technological Research Laboratory, Indian Central Jute Committee, Calcutta.	A Research laboratory under the Indian Central Jute Committee for the specific purpose of carrying out research investigations on the technology of jute and allied fibres, for the study of the fundamentals of fibres from physical and chemical stand-points and for finding new uses for them. The specialised lines of investigations comprise fibre physics, inorganic chemistry and spinning.	As in the case of the Lac Research Institute, the Jute Technological Research Laboratory has a permanent staff of research officers and research assistants for the work of the institute and there is no regular intake of research workers for training. It is, however, assessed that the available facilities of the institute can be utilized for the training of about 4 research workers in the various aspects of fibre physics, fibre chemistry and with special reference to jute fibre	The available facilitie by way of staff, equipment and accommodation are satisfactory in all respects.
Institute of Palaeo-Botany.	The object of the institute is the promotion of higher study and research in palaeo-botany in the widest sense both in its academic aspects and in its application to problems of economic geology. The Institute provides facilities for the training of research workers in Palaeo-botany and related fields.	The institute has now on its staff 4 research workers and no details are available as to how many research workers can be trained at a time.	The Institute is still in a formative stage and the necessary facilities by way of staff, equipment and accommodation are in the process of organisation.

1	2	3	4
Tata Institute of Fundamental Research, Bcmbay.	Research in theoretical physics, experimental physics, mathematics and advanced statistics with special reference to study of cosmic radiation, quantum mechanics and theory of elementary particles, nucbar physics, etc.	The number of research students now being taken in for training is about 10 and will increase shortly by the completion of the selection of a professorial staff.	The Institute is very well equipped for research investigations in physics, with special reference to cosmic rays and nuclear physics. Ist is also one of the centtres of atomic research in the country and will shortly have a high energy betation.
Forest Research Institute, Dehra Dun.	The Institute is primarily maintained for research in forestry and forest products. The various aspects of research of the institute comprise forest botany and pathology, forest zoology and entomology, silviculture, biochemistry and minor forest products, wood technology, forest statistics, composite wood and wood preservation, wood working and timber mechanics, wood seasoning and paper and cellulose.	In the Research Divisions of the Institute, facilities are available for the training of research workers to a limited extent. Such facilities may be assessed at 3 in biochemistry and minor forest products, 2 in wood preservation, 2 in plywood, 4 in paper and cellulose, and 2 in timber physics, 8 in Forest botany and 2 in Forest entomology.	The Institute is very well equipped for research in all aspects of forest products, major and minor such as timber, gums and besins, essential oils, etc.
Mathematical Instrument Office, Calcutta.	Developmental research bearing on mathematical, optical and physical instruments and accessories.	There is at present no provision for the training of research workers.	
National Physical Laboratory, Delhi.	Maintenance of and research on Fundamental and Derived standards. Research on industrial standards, *viz.* standards of quality, standards of Performance and standards of practice. Investigation of raw materials for industries. Standardisation of raw materials, processes and finished products. Exploration of the practical application of the new results of fundamental research with a view to their use in industry. Framing of and advice on specifications. Scientific and Industrial Training. Scientific Publications.	The laboratory is in the course of establishment.	
National Chemical Laboratory, Poona.	Development of the means for the application of scientific knowledge to practical problems of human welfare in general and in particular promotion of research in industrial chemistry and the chemical utilization of the rawmaterial resources so as to help the development of the country and its industries. These objectives will be carried out through pursuit of research in inorganic chemistry including analytical chemistry, physical chemistry including electro-chemistry, chemistry of high polymers, organic chemistry, biochemistry including biological evalution, chemical engineering, fermentation technology.		
National Metallurgical Laboratory, Jamshedpur.	All aspects of metallurgical research—both fundamental and applied as well as research on ores, minerals and refractories as applied to metallurgy.	The laboratory is in the process of establishment.	

1	2	3	4
Central Glass and Ceramic Research Institute, Calcutta.	Research on glass, pottery, porcelain, enamels and refractories; testing and standardisation, technical assistance to the Industy, dissemination of information and training of technologists.	The laboratory is in the process of establishment.	
Fuel Research Institute, Dhanbad.	Fundamental and applied research on coal and other fuels liquid and gaseous. Physical and chemicals survey of coal resources, carbonisation and by-products (including colloids, rheology, liquid fuels and oils), fuel chemistry including hydrogenation, synthesis, plastics and coal preparation, physics of fuels and including pyrometry, calorimetry, X-ray and spectroscopy gaseous fuels and fuel engineering.	Ditto.	
Building Research Station. Road Research Institute. Leather Research Institute. Central Drugs Research Institute. Electro-chemical Research Institute. Food Technological Laboratory.	Details plans for the establishment of these National Research Laboratories are being prepared.		

63. The chief centres of scientific and industrial research in the country at present are—the Indian Institute of Science, Bose Research Institute, Indian Association for the cultivation of Science, the Tata Institute of Fundamental Research and the National Laboratories of the Council of Scientific and Industrial Research that are in the process of establishment. There are also several other research institutions, meant specially for certain specific branches of science and Technology such as Solar Physics, Jute, Lac, Fisheries. etc which are important in their respective fields.

64. The Indian Institute of Science covers a wide range of subjects for research —physics, general and inorganic chemistry, organic chemistry, physical chemistry, biochemistry, aeronautics and communication engineering. Research facilities in metallurgy, internal combustion engineering and power engineering are in a formative stage. The Institute is perhaps the oldest and the best equipped whole-time research institute in the country at present and the lines of research in each of the branches of science are indicated in column 2 of statement VII. Excepting nuclear physics, all other branches of physics are covered in the Physics Division. Besides general, organic, inorganic and physical chemistry, the Chemistry Division covers fermentation technology. The Biochemistry Division specialises in good and nutrition problems, sanitation chemistry including water sewage and trade wastes, soil sciences and enzyme chemistry. An important aspect of research development in the Institute is industrial research which of late is receiving considerable attention. A large number of research schemes of industrial importance bearing on plastics, catalytic synthesis, synthetic drugs, electro-chemistry, vegetable oils and fats and industrial fermentations are being investigated and in many cases on a pilot plant scale. The departments are equipped with all the unit process plants and for the development of certain processes, such as, for instance, for the manufacture of hydrogen-peroxide, formaldehyde, carbon-disulphide etc., pilot plants have been constructed. A noteworthy feature of the Fermentation Chemistry Section is the National Collection of Type Cultures. The research scholars of the institute sometimes submit thesis based on the results of their investigations for higher research degree of Indian Universities. The Institute also awards Associateship and Fellowship of the Institute

to deserving research workers. The former is equivalent to M.Sc. by research of Indian Universities. The lines of investigation of the Institute are indicated in brief in the following :—

General & Inorganic Chemistry

Reactions at high temperatures, absorption and emission spectra, colloidal properties of rubber, ore-dressing and concentration of ores, electro-chemistry, conductivity, fermentation chemistry and microbiology, enzymes, antibiotics and developmental research of an applied character in industrial chemistry, plastics etc.

Bio-chemistry

Food and nutrition problems, physiological chemistry, soil sciences and plant nutrition, enzyme chemistry, dairy chemistry, sanitation chemistry including water sewage and trade wastes, medical chemistry.

Physics

Optics, spectroscopy, magnetism, magneto-optics, x-rays, electron-diffraction, ultra-sonics, physical minerology and crystallorgraphy.

Aeronautics

Aeronautics and designing of wind tunnels etc.

Chemical Engineering

Design and operation of chemical plants and equipment.

Organic chemistry

Coal-tar products including dyestuffs, wood-tar products, unit processes in organo-chemicai operations, essential oils and resins, synthetic terpenes, aynthetic drugs, Indian medicinal plants, theoretical investigations in general organic chemical industry.

Metallury

Developmental research on metals and alloys from ores, theoretical investigations such as fatigue in metals etc.

Communication Engineering

Electronics, wireless propogation, atmospherics, microwave propogation.

Power Engineering

Thermal and hydro-electric power generation and transmission, civil, mechanical and hydraulic engineering as applied to power engineering, high voltage engineering etc.

64. The Bose Research Institute in Calcutta is "devoted to the full investigation of the many ever opening problems of the nascent science which inculdes both life and non-life with the application of methods of science to problems of agriculture, industry and medicine". The specialised branches of research carried on are physics and biophysics, inorganic chemistry and biochemistry, plant physiology, plant breeding and cytogenetics, microbiology and anthropology. The lines of research in each of the above branches are as follows :—

Physics

Nuclear fission and disintegration, artificial radio activity, large air showers, production of cosmic ray bursts and penetrating showers in different absorbing media, x-ray diffraction methods for the study of solid and liquid state and structural determination of large molecules of bacteriological origin and of their polymers, application of spectroscopy for the study of absorption spectra of biological substances and identification and quantitative estimation of elements present as impurities in organic compounds, productoin of ultra-sonics and study of their application in biology, industry etc.

Biophysics

Properties of natural and artificial membranes, bio-electric potentials, electro-phoresis, effect of short-wave radiation and neutrons of living tissues.

Chemistry

Study of plant products, their isolation and synthesis, effect of manurial treatment on growth and yield of plants of economic importance, soil and plant tissue analysis, radio chemistry.

Microbiology

Study of antibiotic substances, retting of fibres, fungal infections of cereals and tropical fruits.

Plant Physiology and Cytogenertics

Plant physiology, plant growth and respiration and transmission of excitation in plants.

65. Research in the theoretical and experimental physics and chemistry is the special activity of the Indian Association for the cultivation of Science in Calcutta and the lines of research in these two fields are :—

Physics

X-rays, and crystal structure, magnetism, light scattering and Raman effect, flourescence and absorption of light.

Chemistry

Chemistry of high polymers.

66. The Tata Institute of Fundamental Research which has started functioning recently specialises in theoretical physics, experimental physics, mathematics, and advanced statistics with special reference to the study of cosmic radiation, quantum mechanics and theory of elementary particles, nuclear physics etc. The institute is very well-equipped in these lines and especially in cosmic rays and nuclear physics. It is also one of the centres of research in atomic energy and will shortly have a high energy betatron installed in its laboratories.

67. Laboratories of the Indian Academy of Sciences, Bangalore, which are in a formative stage at present and will start functioning shortly, will cover research in physics, crystallorgraphy and mine rology.

68. Besides the above, there are eight research institutions—the Solar Physics Laboratory, the Central Marine Fisheries Research Institute, the Lac Research Institute, the Cotton Technological Laboratory, the Jute Technological Laboratory, the Institute of Palaeo botanical Research and the Forest Research Institute, all of which are meant for research in certain specific branches of Science or technology. At the *Solar Physics Laboratory, Kodaikanal*, research in theoretical and experimental solar physics is carried out with particular reference to atomic contours, measurement of the temperature of the sun's disc using the band spectra of C.H. molecule, structure of K and H lines, solar corona and magnetism of sun's spots. The laboratory also carries out routine observations relating to the spectro-heliograph of the sun's spots, visual observations of the sun's prominences etc. A monthly bulletin of statistical solar calculations is published by the laboratory. At the *Nutrition Research Laboratory, Coonoor*, is carried out fundamental research in the science of nutrition and application of basic knowledge to studies in the field, analysis of natural and processed foods for their nutritive value and other related aspects. The laboratory also undertakes the training of nutrition research workers. The *Lac Research Institute at Ranchi* carries out investigations on the improved methods of cultivation, manufacture and utilization of lac and lac products. The objectives of the Institute of the Paleo-Botany which has been established recently is the promotion of higher studies and research in Paleo-botany in the widest sense both in its academic aspects and in its application to problems of economic geology. The Institute provides facilities for the training of research workers in Paleo-botany and

related subjects. The *Forest Research Institute* is maintained primarily for research in forestry and forest products. The various aspects of research at the Institute comprise forest botany and pathology, forest zoology and entomology, silviculture, biochemistry and minor forest products, wood technology, forest statistics, composite wood and wood preservation, wood working and timber mechanics, wood seasoning and paper, pulp and cellulose. *The Central Marine Fisheries Research Station* in Mandapam which is now being established will carry out, when completed, comprehensive research in marine biology and oceangraphy with particular reference to sharks and rays, mackerel, sardines, prawns and crabs, edible mollusca, plankton, fish food and sea flora. The Institute will also conduct a 10 month post-graduate course in marine biology with a view to training candidates for undertaking independent developmental research in fisheries.

69. The National Laboratories of India—chain of which is in the process of establishment under the auspices of the Council of Scientific and Industrial Research represent what might truly be called a positive and conscious effort for the promotion of scientific and industrial research in the country and the development of the country's industries. A brief summary of the scope and functions of the five National Laboratories—the National Chemical Laboratory, the National Physical Liaboratory, the National Metallurgical Laboratory, the Central Glass & Ceramic Research Institute and the Fuel Research Institute is given below. Plants are also under-way for the establishment of Road Research Institute, Building Research Station, Leather Research Institute, Food Technology Laboratory, Electro-Chemical Research Institute and Central Drug Research Institute.

National Physical Laboratory

The scope and functions of the National Physical Laboratory for India comprise—

(*a*) Maintenance of and research on Fundamental and derived standards.

(*b*) Research on industrial standards, *viz.*,

- (i) Standards of quality,
- (ii) Standards of performance, and
- (iii) Standards of practice.

(*c*) Investigation of Raw Materials for Industries.

(*d*) Standardization of raw materials, processes and finished products.

(*e*) Exploration of the practical applications of the new results of fundamental research with a view to their use in Industry.

(*f*) Framing of and advice on specifications.

(*g*) Scientific and Industrial Testing.

(*h*) Scientific Publications.

The above functions of the laboratory will be carried out through the following divisions—Weights and Measures, Applied Mechanics and Materials, Heat and Power, Optics, Electricity, Electronics and Sound, Building and Housing Research, Hydraulic Research and Analytical Chemistry. The details of the subjects covered by the various divisions are as follows :—

Division of Weights and Measures

1. This section will undertake all the metrological work of the laboratory and shall be the custodian of the standards of mass and length. It will be responsible for installing suitable apparatus and equipment for supplying sub-standards to other testing institutions. The following heads will show the scope of work.

Standards of length, Mass and Time. Standard Clocks, Balances, weighing scales and weights. Measuring scales and graticules. Gauges, surveying tapes and chains. Gravity balances. Specific gravity and density tests. Calibration and testing of volumetric glassware, hydrometers, gas measuring instruments, barometers, fine instruments and precision screws. Dividing engines, ruling engines, Mechanical meters.

Division of Applied Mechanics & Materials

2. **Elastic constants, elastic fatigue.** Hardness, Mechanical properties at high temperatures. **Fluid friction, research on bearing** and lubrication problems. Vibration in machines and automobile **engines. Vibration in bridges and structures.** Boiler and Gas cylinder problems. Welding problems. **Bolt tests. Brake and clutch lining problems.** Engineering instruments. Dynamometers and impact testers. **Behaviour of materials** under high pressure. High vacuum techinque Computing machines.

Division of Heat and Power

3. **Physical constants.** Thermometer testing; thermometeric substances; temperature standards **Pyrometry. Heat measurements,** heat transfer, heat loss in pipes, heat insulating materials. Fire **resistance tests. Heat engines, turbines,** automobile and aero-engines. Jet and rocket propulsion **engines. Gas liquifiers and efficiency tests;** refrigeration and refrigerants, cold storage problems; **low temperature research.** Investigation of the physical effects due to extremes of temperature and **measures for their control.**

Section of Optics

4. **Optical constants.** Wave-length standards; light sources; interferometry; refractometry; **polarimetry and polaroids.** Colorimetry. Spectrometry and spectrophotometry. Radiation mea- **sures and standards. Infra red** and ultra violet research. Optical instruments. Quartz and other **crystals. Photographic standardization;** research on photographic materials; development of lenses, **cameras and accessories.** Microscopy and Microphotography, Photometry, Illumination Research, **Development of efficient light sources.** Fluorescent lighting.

Division of Electricity

5. **The section of Electricity** will be sub-divided into the following sub-sections :—

(*a*) **Electrical Standards** Section.—Fundamental units. Standards of resistance, current voltage, **inductance, capacity** etc. Electrical measurements and bridges. Magnetic testing **and standards**; magnetic tests at radio frequencies. Standards of radio and audio frequencies.

(*b*) Electro-technics Section.—Direct and alternating current measurements. Power generators, **motors, storage** batteries. Electro-chemistry, Alternating currents, power **transformers;** power transmission. Resistance of materials. Insulating materials. **Tests at High Voltage.** Voltage regulation. Circuit breakers. Dielectric tests. Calibration and tests of electrical instruments. Transmission and supply of power.

(*c*) *X-ray and Radiology Section.*—Crystal structure, ionisation, wavelength measurements, **x-ray spectrometry, x-ray** dosage and intensity measurements. Electron diffraction. **Standardization** of radio-active substances and radiations. Induced radio-activity.

Divison of Electronic and Sound

6. **Electronics. Thermonics.** Electron tubes. Photoelectric cells. Electronic devices. Electronic **measuring instruments.** Electron Microscopy.

Oscillators, transmitters and receivers. Special circuits and apparatus development. Antenna **systems.**

Micro-waves; radar equipment; directional wireless, transmission; reception television, Ionosphere and **Throposphere investigations.** Atmospherics.

Industrial electronics. Dielectrics at high frequencies, dielectric heating etc.

Sound.—Sound transmission, sound absorption and sound intensity measurements. Accoustical instruments. Audio frequency standards. Noise problems; noise and sound insulating materials. Noise-meters. Building accoustics. Sound recording and reproduction. Baffles and sounding boards. Problems in electro-acoustics. Sound ranging; echo-sounding, Ultrasonics, Musical instruments.

Division of Building and Housing Research

7. Noise abatement ; sound proofing. Transmission of heat in buildings. Air-conditioning. Reverberation of halls ; acoustics of buildings. Transmission, reflection and absorption of heat and light in buildings. Building materials ; strength and life of building materials ; Plasticimeter tests. Weather proofing. Road impact and surface tests. Soil mechanics.

Division of Hydraulics Research

8. Fundamental problems in hydrodynamics and hydraulics. Eddy currents. Turbulence. Big and small waterfalls. Evaporation ; conservation ; utilisation and control of water. Flood control. Erosion problems. Seepage. Tidal effects. Water flow meters. Flow in open and closed channels and orifices. Hydraulic machinery. Turbines.

Division of Analytical Chemistry

9. This section will undertake the analytical work for all the Divisions of the Laboratory.

The National Chemical Laboratory

The scope and functions of the National Chemical Laboratory relate to the development of the means for the application of scientific knowledge to practical problems of human welfare and will be largely of a fundamental, basic and applied nature on the lines likely to promote research in industrial chemistry and the chemical utilisation of the raw material resources so as to help the development of the country and its industries. The work of the National Chemical Laboratory will be carried out through seven main devisions—Inorganic Chemistry including analytical chemistry, Physical chemistry including electro-chemistry, Chemistry of High Ploymers, Organic Chemistry, Bio-chemistry including biological evaluation, Chemical Engineering, Industrial Fermentations and Survey and Intelligence. The scope and work of each of the above divisions will be as follows :—

Division of Inorganic Chemistry including Analytical Chemistry

I. Acids, alkalis, salts and heavy chemicals ; Fertilizers ; Pure inorganic salts ; Chemical and analytical reagents ; Inorganic complexes ; Radioactive substances and isotopes ; Chemistry of the stratosphere ; Industrial gases ; Mineral resources and rare earths ; Utilization of mineral wastes ; Analytical techniques ; Specifications of materials ; Standards of purity and purification of chemicals and standard of analysis.

Division of Physical Chemistry including Electro-chemistry

II. Industrial catalysis ; High pressure and high temperature reactions ; Technique and use of low pressures ; Low temperature and its applications ; Preparation of colloidal solutions , pastes, emulsions, foams ; Physical properties of colloidal systems, especially in relation to industrial problems ;

Preparation of sprays ; Physico-chemical aspect of the distribution of insecticides and fungicides; Spectroscopy ;Ultra-centrifuge ; Crystallographic studies ; X-ray analysis ; Electron microscope ; Polarography ; Magnetochemistry ; Photo-chemistry ; Hetrogeneous equilibria ; Thermodynamics ; Radio activity ; Modern electroplating and Electrodeposition, Electro-metallurgy ; Electro-thermal process ; Electro-chemistry as aid to analytical chemistry ; Electrolytic oxidation and reduction ; Electrolytic production of chemicals ; Study of corrosion ; Determination of pH and its applications ; General electro-chemistry.

Division of the Chemistry of High Polymers

III. Chemistry of polymerisation and of polymers ; Natural resins and plastic materials ; Synthetic plastics ; Rubber and Rubber substitutes ; Industrial applicational Gums, Glues and adhesives ; Paints, pigments and varnishes.

Division of Organic Chemistry

IV. Coal and coal-tar products ; Organic solvents ; Intermediates for dyestuffs and drugs ; Vitamins and Harmones ; Fine Organic chemicals, Plant Chemistry ; Alkaloids and active principles of plants, Essential oils, perfumes and cosmetics ; Natural and synthetic tanning materials ; Carbohydrate chemistry ; Oils, fasts and waxes ; Preparation of insecticides and fungicides ; Antiseptics and disinfectants ; Preparation of sizing materials ; detergents, wetting agents ; Bacteriostatic substances; Explosives and war chemicals ; Petroleum industry Micro-chemical analysis ; Utilisation of organic waste ; Therоretical investigations.

Division of Biochemistry including Biological Evaluation

V. Metabolic studies of higher animals ; Metabolic studies of lower organisms ; Bio-chemistry of proteins, fats and carbohydrates ; Nutritional investigations ; Food and food products ; Blood, urine and other biological fluids ; Enzymes ; Vitamins and harmones ; Isotopes and the use of labelled elements in biological processes ; Tissue culture and cultures of organs and higher organisms ; Bacteriostatic substances ; Pharmaceutical research; Plant biochemistry ; water and sewage chemistry ; utilisation of plant and animal waste ; Microbiology ; Drugs and their active principles ; Standards ; Drugs acting on the nervous system ; the respiratory system ; Drugs acting on the kidneys ; Drugs acting on the reproductive and genital organs ; Chemotherapeutic agents; Antiseptics and disinfectants ; Metabolic stimulants and other gland products ; Sera, vaccines, antigens, and other immune bodies ; Insecticides and fungicides ; Toxic chemicals ; Toxins ; New chemical and medicinal agents in ezperimental stages.

Division of Chemical Engineering

VI. Design and construction of plant in chemical and allied industries ; Mechanical processes ; Fuel and power ; Flow of heat ; Combustion ; Furnaces and kilns ; Flow of fluids ; Absorption and Extraction; Evaporation, distillation and desiccation ; Diffusion ; Humidification and dehumidification High pressure equipment ; Lower pressure equipment ; Low temperature equipment ; Gas producers Improvement of equipment for unit operation ; Help and collaboration in all pilot plant and semi-commercial scale experiments.

Division of survey and intelligence

VII. Library ; Ressearch and technical information service ; Survey of raw materials ; Translation Service ; Scientific liaison ; Museum ; Publications and publicity.

National Metallurgical Laboratory

The National Metallurgical Laboratory when completed will cover all aspects of metallurgical research both fundamental and applied and will also carry out research on ores, minerals and refractories as applied to metallurgy. The several fields in which such investigations would be carried out are chemical analysis, physical chemistry, physics as it affects metallurgical problems, preparation and smelting of metallic ores, melting, heat treatment and working of metals and alloys research into the structure and physical properties of metals and alloys, electro-deposition and surface treatment of metals and research on refractories. The technological aspects of the functions relate to ore dressing and concentration, wet extractions, smelting, melting and heat treatment of metals and alloys.

Central Glass & Ceramic Research Institute

The subjects of research at the Institute will be glass, pottery and porcelain, enamels and refractories, and its functions will be fundamental research on different branches of glass and ceramics, testing and standardisation, technical assistance to the Industry, dissemination of information and training of technologists. The following indicates the initial programme of work of the Institute.

Testing, grading and standardisation

1. The Institute will undertake testing, grading and standardisation of raw materials and finished goods. This will include calibration of appliances and control of instruments as well.

As to the standards by which performance is to be judged, rigid adherence to specifications prevailing in other countries may not be practicable. The Institute will help in formulating standards suitable to Indian conditions. These specifications will be subject to revision from time to time as the industry progresses.

Benefication of raw materials.

2. An examination of raw materials may reveal defects which are responsible for complaints in manufacture. For instance, glass makers have generally complained of the poor quality of raw materials and they consider that this has largely contributed to the undesirable colour and poor appearance of glass articles.

Systematic investigations into the improvement of inferior quality materials such as sands, clays, etc. will be taken up and suitable methods for their benefication will be worked out. This work is expected to be of very great value in the utilization of raw materials which may otherwise be of little use.

Improvement in existing operations

3. (*a*) ***Furnaces.***—A common complaint of many manufacturers is that the furnaces are wasteful of fuels and do not attain the desired temperatures. It is well-known that many of the defects in glass and ceramic manufacture can be eliminated by maintaining proper temperature and furnace conditions and that much saving in the cost of production can be effected by improvement in furnace design and technique. Progress with regard to the introduction of improved plant is of necessity gradual. Through models, charts and small booklets giving technical information, and by arranging visits of the staff to factories, the Institute will help in the employment of better furnaces.

In the early stages, it is proposed to give technical advice to help the dustry on furnace matters, but a note of caution has to be sounded in this connection because an organisation of this nature cannot function like a firm of constructional and designing engineers and cannot undertake installation of furnaces.

(*b*) *Annealing.*—The problem of annealing is largely related to that of furnaces. By suggesting proper annealing equipment by working out annealing schedules and by demonstrating and encouraging the use of appliances such as strain viewers, the Institute will help in improving annealing operations.

(*c*) *Composition.*—Serveral guiding principles relating to the composition of batches for differen articles are known and much information exists in literature. The Institute will help the manufacturers by giving them technical information and by carrying out investigations whenever considered necessary.

(*d*) *Methods of Control.*—If improvement in the quality of products has to be effected and maintained, efficient methods for controlling industrial operations have to be adopted. The value of such controls has not been fully realised in this country and for this purpose the Institute will encourage and help manufacturers to fit up control laboratories in their works for routine checking and tests.

Collection of Data

4. If the use of control methods and maintenance of standards have to be of real value, it is unnecessary that a great drive be made for keeping proper records and charts, so that the causes of trouble can be easily located and remedied. To point out a parallel case, in the sugar industry where daily returns and charts are maintained, it is now well-known that the information is of very great value in the improvement of average recovery. The Institute will help in drawing up schedules and charts that should be maintained in glass and ceramic factories and will collect data which will be useful in the deveopment of these industries.

Dissemination of information

5. This will be carried out in the following ways :—

(1) By arranging publication of bulletins in simple form on important and technical topics.

(2) By publishing reports and reviews.

(3) By organising an intelligence section which will work in collaboration with the Central Statistical Section under the Council.

(4) By arranging discussions, lectures, demonstrations and industrial film programmes.

Development of new lines of manufacture

6. There is a number of articles which are not yet manufactured in the country and are imported from abroad. In many cases the processes of their manufacture are highly developed and well established in foreign countries, but for their introduction in this country, apart from economic considerations, two important considerations are involved ; one is the technological aspect including adaptation to Indian raw materials and conditions, and the other the engineering aspect including installation and operation of plant. The former aspect will be within the scope of activity of the Institute but it will also extend co-operation to the latter.

Fuel Research Institute, Dhanbad

The scope of work and functions of the Institute relate to fundamental and applied research on coal and other fuels, and will be carried out through the following divisions—Physical & Chemical survey of coal resources, carbonisation and by-products (including colloids, Rheology, Liquid fuels and Oils), Fuel Chemistry including hydrogenation, Synthesis, Plastics and coal preparations, physics of fuels including gaseous fuels, wood fuels, fuel engineering and intelligence.

All the National Laboratories will, when completed, have a large staff of permanent research workers. They will also provide facilities for the training of a considerable number of research workers on stipendiary or fellowship basis.

7. Having described in the preceding paras. the research activities of 'Special Institutions' and the University Research Centres, it is proposed to present in the following statement an analysis of the facilities available in the country for the training of research workers and the present rate of outturn of such trained personnel in the various branches of science and technology. Column 2 of the statement gives the number of research workers for whom training facilities are available at present. Since many of the research establishments especially University research centres and scientific institutions in the Western and the Northern Zones have not indicated the number of research workers for whom training facilities are available, an approximate estimate has been made of such numbers from a general consideration of the conditions obtaining in these institutions. As regards the present annual outturn of trained research workers, no correct estimates have been furnished by the institutions, presumably, in view of the fact that research training does not ordinarily conform to any specified time limits unlike other training or educational courses and the scholars under training stay at the institutions either as long as their scholarships or stipends last, or until they complete their work for a higher degree or diploma, both of which show great variations. Often research students also leave the institutions for suitable posts outside without, however, completing the training. Besides, in many institutions the available research training facilities are not being fully utilised, chiefly due to as has been stated earlier in this section, lack of suitable fellowships or scholarships to attract research students and the teaching load on the tutorial staff as Science Colleges being too heavy to permit of any considerable research on the part of the staff. All these factors consequently, render the present rate of outturn of trained personnel indeterminable. We have, however, made an attempt to present in column 3 of the statement the possible ratio on the assumption that the average period of research training is 3 years and that, if all the available training facilities are fully utilised, the annual outturn will be about 35% of the total number of research workers for whom training facilities are available.

STATEMENT VIII

Facilities for the training of Research Workers

Field or research	No. of research workers for whom training facilities are available.				Possible rate of outturn of trained Research Workers	
	Southern Zone	Western Zone	Eastern Zone	Northern Zone	Total	(Per year)
(A)						
General Physics			16		Physics	
Spectroscopy			2			
Optics					138	46
X-rays and crystallography	31	13	5	30		
Magnetism						
Ultrasonics			1			
Muclear Physics			9			
Cosmic rays			5			
Electronics			3			
Bisphysics			3			
Theoretical Physics			5			
Applied Physics			8			
Solar Physics and Astrophysics	7					
(B)						
General Chemistry			17			
Inorganic Chemistry			2		Chemistry	
Organic Chemistry	90	64	4	35	309	103
Physical Chemistry			8			
Applied Chemistry			20			
Biochemistry	60		4			
Microchemistry	..	..	1	..	..	..
Nutrition Chemistry	4	..	..	..	..	..
(C) Mathematics	12	7	2	10	Maths 31	10
(D) Statistics	7	..	2	..	Statistics 9	3
(E) Botany	19	9	12	23	Botany 63	21
Palaebotany	..	..	..	4	..	..
(F) Geology	11	3	3	4	Geology 21	7
(G) Zoology	24	6	5	17	Zoology 52	18
(H) Applied Biology	3	..	..	..	3	1
(I) Marine Biology	15	..	..	..	15	5
(J) Physiology	..	..	4	..	4	1
(K) Lac and lac products	..	..	7	..	7	2
(L) Wood technology	..	..	..	..	4	1

Development and Expansion.

8. All the important educational and research institutions in the country have plans for the development of higher scientific education and research. These plans are described in the following analytical statements on the institutions with the particular reference to the objectives of the plans, consequential increase in the intake and outturn of students in various categories and financial implications thereof.

STATEMENT IX

Institution	Objectives of the plan	Increased intake or output per year	Financial implications
(1)	(2)	(3)	(4)
SOUTHERN ZONE			
1. *Madras University*			
Bio-Chemistry Department	Expansion of research facilities in biochemistry with a view to increasing the provision for research workers. To organise a post-graduate course in fermentation with the Botany Department.	M.Sc., Ph.D. or D.Sc.—10 Industrial fermentations—10	*Capital*: Buildings —Rs. 70,000. Equipment—Rs. 50,000. Recurring —Rs. 50,000 per year.
Zoology Department .	Expansion of research facilities with particular reference to the study of marine fauna and marine fisheries.	M.Sc., Ph.D. or D.Sc.—6	*Capital*: Buildings —Rs. 1·5 lakhs Equipment —Rs. 85,000 *Recurring* —Rs. 33,500
Botany Department .	General expansion of research facilities in botany and particular intensification of research in soil microbiology comprising antagonism in soils, microbiological and chemical and study of immunology of plant virus nucleo protein, study of relationship between insect vector and plant virus transmission, seralogical classification of plant virus artigen, horticulture.	M.Sc., Ph.D. or D.Sc.—6	*Capital*: Buildings —Rs. 1·5 lakhs Equipment —Rs. 1·5 lakhs Recurring —Rs. 45,000 per year.
Satistics Department	Expansion of facilities by way of staff and equipment for training in statistics and statistical methods. 	M.Sc. . . . 6 P. G. Course in Statistics 60	*Capital*: Buildings —Nil. Equipment—Rs. 20,000 Recurring —Rs. 7,000 per year. (The whole of the grant required to be provided by the Central Government.)
2 *Mysore University*			
Central College, Bangalore	Separation of B.Sc. and B.Sc. (Hons.) from other post-graduate courses by starting a separate college for B.Sc. Strengthening of the present resources for post-graduate studies and research in all the science departments. Doubling the output of B.Sc. (Hons.) & M.Sc. *Physics*.—To build up a strong research training laboratory for work in X-rays, magnetism, nuclear physics, wireless and electron-difraction. *Chemistry*.—Research development in organic and physical chemistry. *Mathematics*.—Starting of a hydrodynamic laboratory and a section for fundamental research in theoretical physics and pure mathematics.	B.Sc. (Hons) . 150 (all branches) M.Sc. . . 100 (all branches) D.Sc. . . 2 to 4	*Capital*: Buildings —Nil Equipment—Rs. 5·15 lakhs Staff Rs. 1·73 lakhs per year. The above relates only to post-graduate research and training and not development projects relating to lower education *e.g.* B.Sc. degree. The whole of the grant is to be provided by the Central Government.

(1)	(2)	(3)	(4)
	Zoology.—Study of chromosomes and protozoan animals, study of the structure of the nucleus of the protozoan for an understanding of the problem of cancer.		
	Geology.—Research in palaeontology, stratigraphy and petrology.		
	Botany.—Research in cytology and collection of herbarium of Mysore flora and forest systematics. Opening of plant physiology and micology branches.		
8. *Travancore University.*			
University College, Travancore	Introduction of M.Sc. courses by exam. in botany and zoology ; expansion of research facilities in all the departments with particular reference to those lines of work in which the institution engaged at present (cf. Table VI, Col. 2).	M.Sc. in Botany . 10—12 M.Sc. in Zoology 10—12 Research provision for 4 more research workers in each department.	*Capital* : Buildings —Rs. 2 lakhs. Equipment and Library—Rs. 8·5 lakhs. *Recurring* —Rs. 50,000. May be possible to secure 50 per cent. grant from the State Government.
4. Central Research Institute, Travancore	Research development in applied biology, applied chemistry, Microbiology and fisheries, mineral survey and research, preventive medicine and statistics. A large number of research projects have been proposed.	The implementation of the various research schemes will result in provision being made in the various divisions for at least 78 research workers besides research development of industrial importance.	*Capital* : Buildings—Rs. 14·5 lakhs Equipment—Rs. 21 lakhs Recurring—Rs. 11·75 lakhs (It might be possible to secure a 50 7. contribution from the Government of Travancore).
5. *Andhra University.*			
College of Science, Waltair.	Expansion of both research and teaching facilities for increasing the outturn of candidates with post-graduate degrees in the various branches of science and technology ; setting up of atmospherics and meteorology department in the university ; setting up of a marine zoological station ; starting of a course in pharmacy and pharmaceutical chemistry.	*Physics* : M.Sc. . . . 10 D.Sc. . . 4 *Chemistry* : M.Sc. in Foods and Drugs . . 4 *Research in drugs, Insecticides etc.* 6 *P. G. Course. in analytical chemistry* 2 Applied Physics including Optics M.Sc. . . 10 *Chemical Technology* Hons. Course . 12 *Geology* : Hons. Course . 10 M. Sc. by research 6 *Zoology* : M. Sc. (by research) 3 *Botany* : D. Sc. 1 M. Sc. 6	*Capital* : Buildings and Equipment—Rs. 13·37 lakhs. *Recurring* —Rs. 2·7 lakhs. (The entire grant is to be provided by the Central Government).

(1)	(2)	(3)	(4)
6. **Indian Institute of Science, Bangalore.**	The development of the institute relates chiefly to creation of facilities in the various departments for research in fields not covered now and expansion of the existing facilities for better research work in the fields now under purview ; besides enabling the institute to cover new lines of activity, the development plan provides for increase in the intake of research workers in the various branches in brief; the various branches as follows :— *Bio-Chemistry.*—Expansion of research facilities in food technology, antibiotics, sanitation chemistry and food nutrition. *Physics.*—Construction of a separate building for housing the activities of the department and expansion of research facilities in the fields of nuclear physics, low temperature physics and applied physics. *Pure and Applied Chemistry.*—Fundamental researches bearing on the structure of molecules in relation to synthetic fuels, hypolymers and drugs; theoretical and applied electrochemistry; utilisation of Indian minerals ; expansion of the physical chemistry section for carrying on researches in Photochemistry and synthetic hydro-carbons; expansion of research facilities in the organic chemistry section for investigations on a pilot plant scale in organic chemical industry.	It is not possible to give a correct idea of the increased intake of research workers into the various departments. It is, however, understood that a good number of research workers will be provided for in each of the departments for training besides the permanent research staff. An approximate is as follows : Sanitation Chemistry . 8 Food and Nutrition . 10 Nuclear Physics . 3 Low Temperature Physics . . 4 Applied Physics 4 General Physics including Optics, spectroscopy, ultrasonics etc.. . . . 5	*Capital* : Rs. 26·90 lakhs. *Recurring* : Rs. 3·3 lakhs. The whole of the grant required will have to be provided by the Central Government.
7. *Annamalai University.*			
Faculty of Science .	Expansion of research facilities of the department of chemistry, physics, zoology and botany with particular reference to research in chemistry, magnetism, X-rays and wireless, fundamental aspects of embryology, coto-toxonomy, cotogenetics, morophology, Introduction of M.Sc. by examination in physics - introduction of B.Sc. Hons. and M.Sc. by examination in Botany.	*Physics* : M.Sc. . . 2 *Botany* : B.Sc. Hons. . 6 M.Sc. . . 4 Additional provision will be made *for more research workers.*	*Capital* : Buildings —Rs. 30,000 Equipment—Rs. 34,500 Recurring —Rs. 29,200 (All but Rs. 1,440 (the salary of a lecturer for the House Course which will be provided by the University) of the whole grant will have to be provided by Central Government.
		Chemistry . . 4 **Physics** . . . . 4 **Zoology** . . . . 3 **Botany** 3	

1	2	3	4
8. Solar Physics Laboratory, Kodaiklal.	Expansion of research facilities in astrophysics and astronomy with particular reference to investigations on rotation and magnetic field of sun spots, solar prominence, light curves of stars and general spectroscopy of stars, general photometry of stars, all aspects of stellar and solar physics. Mounting of a 100 inch telescope and 20 inch telescope.	There will be an increase in the research training facilities but no details can be given at this stage.	The financial implications of the project are not yet available since the institution is an establishment under the Central Govt. It is understood that the cost of the whole project would have to be borne by the Central Government.
9. Maharaja's College, Ernakulam.	Introduction of three-year B.Sc. (Hons.) course in Physics, mathematics, botany and zoology. Introduction of a two-year post-graduate diploma course in fermentation technology, heavy chemicals and textile chemistry. *Development of post-graduate research along the following lines.* *Physics*:—Meteorology of the west coast ultrashort-wave propagation and its bearing on soils; wireless. *Mathematics*.—Post-graduate training and research in navigational astronomy and research and statistics. *Botany*.—Classification of Indian medicinal plants occuring in the west coast and the study of their anatomical characteristics. *Zoology*.—Marine and fresh water fisheries along the west coast.	*B.Sc. Hons.* Physics . . . . 6 Mathematics . . . . 6 Botany . . . . 6 Zoology . . . . 6 *P.G. Diploma in Industrial Fermentations* : Physics . . . . 6 Mathematics . . . . 6 Botany . . . . 6 Zoology 6	*Capital* Buildings —Rs. 4 lakhs. Equipment —Rs. 7 lakhs. Recurring – Rs. 1·05 lakhs per year. (All the grants required will have to be provided by the Central Govt.)
10. Marine Fisheries Research Station.	Completion of the establishment of the institute at Mandapam and the development of the existing activities on a larger scale with a view to collaborating with foreign countries and studying of conditions obtaining in the Indian ocean. It is also proposed to increase the intake of students for the short-term and long-term training to 40 per year. The research programme of the institution for the next 5 years comprises research in marine biology and oceanography with particular reference to sharks, rays, mackerel, sardines, prawns and crabs and edible mollusca; surveys and research on plankton and sea flora.	No information.	Full financial implications of the project have not been given but it is understood that, since the establishment is under the Central Government, the entire cost of the project will have to be borne by the Government of India.
11. St. Joseph's College Trichinopoloy.	Expansion of research facilities in the departments of physics, chemistry, botany, and zoology; introduction of B.Sc. Hons. in chemistry.	B.Sc. Hons. in Chemistry . 6 *Research* : Chemistry . . . . 4 Physics 4	*Capital* : Buildings —Rs. 5 Lakhs. Equipment —Rs. 2 lakhs. *Recurring* —Rs. 68,500 Per year. **The whole of the grant will have to be provided by the Central Government.**

1	2	3	4
12. Presidency college, Madras.	General expansion of research facilities in the departments of physics, chemistry, mathematics, botany, zoology and geology. Details of particular lines of development in each branch are not available.	Details of the increase in the provision for research workers have not been specified. 50 per cent increase in the existing staff in order to enable the staff to find time for research.	*Capital*: Buildings Rs. 10 lakhs Equipment Rs. 6 lakhs *Recurring* Rs. 1·7 lakhs The scheme for development has been submitted to the Govt. of Madras for their views but no information is yet available as to what part of the grants required are going to be met by the Govt. of Madras.
13. Christian College, Madras.	Development of research in chemistry, chemical kinetics dielectric constants, substantivity of dyes. Kinetics and diazo reactions, structure of lakhs.	Consequential increase in the intake of research workers has not been specified.	*Capital* Buildings Rs. 1 05 lakhs Equipment Rs. 90,000 *Recurring* Rs. 32,500 It appears that the entire grants will have to be met by the Government of India.
	Physics.—Photo- elastic measurements of glass and plastics: investigations on elastic properties by ultrasonic oscillators.		
	Botany:—Cytology Morphology of certain species.		
	Zoology.—Morphology, Entomology, Ecology, Marine Ecology and Vertebrate Embryology.		
14. American College, Madura.	Introduction of B.Sc. Hons. course in physics, chemistry, botany & zoology, organization of post-graduate research in physics and chemistry	Details of intake or outturn of Hons. course are not given. It may however be presumed to be 12 students in each of the 4 sciences.	*Capital* Rs. 6 lakhs Equipment Rs. 2 lakhs *Recurring* Rs. 42,000 per year Since the Principal is not in favour of receiving grant from foreign mission any more the necessary grants will have to be provided by the Central Govt.
15. Madura College, Madura.	Organisation of post-graduate course in Physics, chemistry & biological sciences and development of research in all these branches.	Post-graduates in all the branches 50	*Capital* Equipment Rs. 5 lakhs *Recurring* Rs. 25,000 (The necessary grants will have to be provided by the Central Government).
16. St. Aloysius College, Mangalore.	Organisation of post-graduate research in Physics & chemistry.	The number of research workers for whom provision will be made has not been specified.	*Capital*: Building & Equipment Rs. 4 lakhs. *Recurring*: Not mentioned. The Head of the Institution feels that he would require 50 per cent. of the capital and 50 per cent. of the non-recurring expenditure from the Central Government.

1	2	3			4
WESTERN ZONE					Rs.
1. College of Science, Nagpur.	Research development in pure and applied physics and with special reference to spectroscopy, X-rays, physics of surfaces, dielectric constants, etc. Starting of post-graduate centre in applied physics leading to the M.Sc. degree.	*M. Sc.*		Research	Capital : Rs. 8 · 5 lacs Recurring : Rs. 1 · 6 lacs
		Physics Applied Physics.	20	No information.	
	Development of post-graduate teaching and research in chemistry, electro-chemistry, photo-chemistry, chemical Kinetics and bio-chemistry.	Chemistry	20	,,	
		Zoology	12	2	
		Botany	14	3	
		Bacteriology	..	3	
		Maths.	20	2	
	Development of research in zoology with reference to systematic survey of various arthrod parasites.				
	Development of Palaeo-botanical research section and bacteriological & embyological research section for post-graduate training of students in Botany.				
	Training and research in applied Mathematics.				
2. Mahakoshal Mahavidyala, Jubbulpore. (Robertson College).	Development of research in spectroscopy in Physics and on the Local Algal Flora in Botany	*M. Sc.*			Capital : Rs. 0 · 4 lacs Recurring Rs. 0 ·15 lacs.
		Chemistry	4		
		Maths.	5		
3. Baroda College, Baroda.	Development of post-graduate research and training of students in physics.	Maths.	2		Capital : Rs. 0 · 22 lacs Recurring : Rs. 0 · 165 lacs
		Physics	2		
		Botany	2		
		Chemistry	6	2	
		Geology	12		
		Maths.	2		
4. Fergusson College, Poona.	Development of research in Physics, botany, statistics and geology.	Physics	2		Capital : Rs. 0 · 11 lacs. Recurring : Rs. 0 · 11 lacs.
		Geology	12		
		Maths.	2		
5. Saugor University.	Development of research in physics, pharmaceutical chemistry, colloids, fisheries, pure and applied entomology, soil erosion and improvement of land in botany and in geology—Increase in the intake & outturn of post-graduates in science.	Physics	50	2	Capital : Rs. 5 · 72 lacs Recurring : Rs. 0 · 85 lacs.
		Chemisty	27	3	
		Botany	8	2	
		Zoology	10	2	
		Geology	2		
6. M. G. Science Institute, Ahmedabad.	Development of post-graduate teaching and research in physics; the latter with reference to magnetic susceptibilities of fluids.	*M. Sc.*		Research	Capital : Rs. 0 · 14 lacs. Recurring : Rs. 0 · 35 lacs.
		Physics	5		
		Chemistry	5		
7. Gujrat College, Ahmedabad M. R. Science Institute, Ahmedabad.	Development of post-graduate teaching and research in physics, chemistry, botany and statistics.	Physics	5	1	Capital : Rs. 0 · 62 lacs. Recurring : Rs. 0 · 36 lacs.
		Chemistry	4	2	
		Zoology	2		
		Maths.	3		
8. Royal Institute of Science, Bombay.	Development of post-graduate research in physics, physical and organic chemistry and botany, the last with special reference to ecological, embryological and palaeo-botanical studies.	Physics	12	12	Capital : Rs. 1 · 97 lacs. Recurring : Rs. 1 · 08 lacs.
		Chemistry	14	10	
		Botany	6	1	

1	2	3			4
9. Karnatak College, Dharwar.	Development of research in chemistry with special reference to chemical insecticides and in Zoology with special reference to poultry genetics and inland fisheries and in botany with reference to pahanerogamic flora of Karnatak.	Chemistry . . . Zoology . . . Botany . . . Geology . . .	2 11 12 1	1 .. 1 ..	Capital : Rs. 0·10 lacs. Recurring : Rs. 0·52 lacs.
10. Pratap College, Amalner.	Development of post-graduate research in chemistry, with special reference to plastics, oils and paints.	Chemistry . . .	2	1	Capital : Rs. 0·2 lacs. Recurring : Rs. 0·06 lacs.
11. Department of Chemical Technology, Bombay University.	Details are given in the section on "Engineering and Technological Education".				
12. Physical Research Laboratory, Shahibag, Ahmedabad.	Development of research in cosmic rays and atmoshperic physics.	Cosmic Rays . Atmosheric physics . . .	4 4	Research	Institution on research scholarships may be necessary.
13. St. Xavier's College, Bombay.	No details.				
14. Shri Samaldas College, Bhavnagar.	Ditto.	*M. Sc.* Physics . . . Botany . . . *M. Sc.* Chemistry . . .	 5 10 5		
15 Dharmendrasinghji College, Rajkot.	No details.	*M. Sc.*—Physics . . . Chemistry .		2 3	
16. Tata Institute, of Fundamental Research.	Development of research in physics, with special refernece to cosmic radiation, nuclear physics and mathematical statistics.	Physics Math. } Research		30	Capital : Rs. 35 lacs. Recurring : Rs. 2 lacs.
17 Department of Bio-chemistry, Nagpur University	Expansion of post-graduate teahing facilities in bio-chemistry, development of research in bio-chemistry.	*M. Sc.* . . . . Research		3 1	Capital Rs. 3 lacs. Recurring : Rs. 0·88 lacs. The C. P. Govt. have sanctioned Rs. 0·67 lacs towards capital and it may be possible to obtain from them Rs. 12,000/-/- towards recurring.
18. Department of Geology, Nagpur University Nagpur.	Study of the ways and means and possibilities of the mineral resources of the province.	*M. Sc.*		8	Capital Rs. 3 Lacs Recurring Rs. 30.000

It is to be noted that the development plants of most of the institutions in the Western Zone are scrappy and uncoordinated. These have been presented in the form of individual research schemes by members of staff of the institutions as their "Personal Schemes" and aim chiefly at solving a particular research problem and not at a progressive development of research in any particular branch of science for building up research schools or centres. However, in the above statement all these schemes have been considered as research development projects in the relevant fields and details of the schemes are omitted. The financial implications column mostly represents the grants required for these schemes.

EASTERN ZONE.

1	2	3			4
1 University College of Science and Technology, Calcutta.	Expansion of facilities for post-graduate teaching and research in all the various branches of science and technology; introduction of new branches of research and improvement of curriculum by addition of more elective subjects.	Post-graduate . . . . Research		213 93	Capital : Rs. 57·15 lakhs, Recurring ; 4·9 lakhs.

1	2	3	4
2. Patna Science College, Patna.	An immediate plan for the initiation for Hons. Post-graduate and research courses in Botany and Zoology; expansion of facilities for research in applied physics with special reference to X-rays, electronics and spectroscopy. A five year plan envisaging provision for extensive researches in nuclear physics, spectroscopy, X-rays, wireless, colloids, dyes, sugar and molasses industry and in botany and zoology; initiation of post-graduate and research courses in bio-chemistry and geology; introduction of the study of applied physics with special reference to the design and manufacture of scientific instruments.	Post-graduate . . . 40 Research 15	*Immediate plan* Capital: Rs 22 lacs Recurring: Rs 5·01 lacs *5 years plan* Capital: Rs 23 lacs
3. Ravenshaw College, Cuttack.	Expansion of facilities for research in chemistry, plant physiology and zoology ,introduction of post-graduate courses in physics, industrial chemistry, botany and zoology; and introduction of degree courses in geology and geography.	Post-graduate . . 64 Research 4	Capital: Rs 5·15 lacs.
4. Bose Institute, Calcutta.	Expansion of research facilities for cosmic ray investigation and expansion of the Department of Bio-physics to make it an all-India centre for research and training in the subject. Expansion of facilities for research in nuclear physics and the setting up of an atomic pile. Expansion of plant breeding stations at Falta for the breeding of new varieties plants by X-ray irradiation and expansion of Plant Physiology, Plant chemistry and Microbiology Sections.	Research . . . 21	Capital: Rs. 5·50 lacs. Recurring: Rs. 1·50 lacs.
5. Indian Association for the Cultivation of Sciences.	Expansion and development of facilities for fundamental researches on X-rays and crystal structure. Magnetism, scattering of light, Raman Effect, Luminescence and absorption of light in the ultra-violet region. Application of the above relevant facilities to the study of highpolymers	Research 18	Capital: Rs. 27 lacs. Recurring Rs. 4·5 lakhs. The Government of India have already sanctioned Rs. 4·32 lakhs capital and Rs. 4·057 lakhs recurring for the above scheme.
6. Mathematical Instruments Office, Calcutta.	Re-organisation and Revision Committee has been set up for the improvement and expansion of the existing facilities of the department.	10 additional research workers can be trained for which a capital grant of Rs. 2 lakhs and a recurring grant of Rs. 0·5 lakhs would be required.	
7. College of Engineering and Technology, Jadavpur, Calcutta.	Creation of research departments in close cooperation with industry and introduction of post-graduate courses in these subjects.	Research 4	Capital: Rs. 2 lacs. Recurring Rs. 0·25 lacs for the training of research workers.

1	2	3	4
			Rs.
8. Technological Research Laboratories of the Indian Central Jute Committee, Calcutta.	Provision of increased research facilities for X-ray and microscopic studies of fibres, dyeing, bleaching and finishing methods for fibres, fine spinning of jute, establishment of weaving section for development of methods for the production of union fabrics.	Research 6	Capital: Rs. 13 lakhs. Recurring : 1·361 acs.
9. Indian Lac Institute, Ranchi.	Increase in the cultivation of lac and to find new uses for the products. Improvement of lac for various products.	Research 6	Capital : Rs. 2 lakhs. Recurring: Rs. 0·25 lakhs. for the training of research workers.
10. Utkal University .	[Post-graduate teaching in Physics, Botany, Zoology and Geology. Development plans for Engineering, Medical and Agriculture Sciences are given in the appropriate sections.]	Post-graduate 48	Capital : Rs. 16 lakhs. Recurring Rs. 1·5 lakhs. (Plan submitted for the interim consideration of the committee).
1. Allahabad University, Allahabad.	The development plan envisages: *Physics*.—Establishment of a well-equipped observatory for research and training in practical astronomy and astrophysics, the former to be carried in cooperation with other observatories. Expansion of facilities for post-graduate training and research in wireless, spectroscopy, X-rays, thermionics, accoustical engineering and light scattering. *Botany*.—Expansion of facilities for post-graduate training and research in plant-physiology, mycology and plant pathology, plant breeding and cytogenetics. *Zoology*.—Expansion of facilities for post-graduate training and research in agricultural zoology and entomology, fisheries, cytology, genetics and anthropology. *Chemistry*.—Expansion of facilities for post-graduate training and research in organic chemistry with particular reference to medicinal plants, synthetics, vitamins, etc. *Inorganic chemistry*.—With particular reference to minerals, alloys and ores, physical and electro-chemistry with special reference to soils, chemical manures and fertilisers and fermentation chemistry.	*M. Sc. Courses.* Physics . . . 12 Botany* . . . 20 Zoology* . . . 30 Chemistry* . . . 40 *Research* . . . 6 *The numbers mentioned are for both M. Sc. and Research. The proportion may be assumed to be 3 : 1.	Capital : Rs. 12 lakhs. Recurring : Rs. 1·4 lakhs. No fresh scheme has been submitted by the University in reply to the questionnaire but the scheme outline in column 2 is based on a scheme submitted by the University in 1947 for the interim consideration of the Scientific Man-Power Committee. There is material difference between the grants asked for in the questionnaire and the grants mentioned in the interim scheme. The above grants represent the maximum of the two.

1	2	3	4
2. Delhi University, Delhi.	The University proposes to institute immediately specialised post-M. Sc. courses in: *Physics.*—Thermodynamics and statiscal mechanics, vacuum technique (including spectroscopy and electron optics), applied optics and microwaves. *Chemistry* —Analytical chemistry (including the analysis of drugs, engineering and building materials), micro-organic analysis, pharmaceutical chemistry and biochemistry. *Biology.*—Biological studies in resistance, physiology and physiological genetics amongst others of which details are under consideration.	*Post-M.Sc. training.* Physics . . . . 20 Chemistry . . . . 30 Biology . . . . . 10 *M. Sc. increase in intake.* Physics . . . . . 15 Chemistry . . . . 20 *Research.* Physics 4	Capital Rs. 3 lakhs. Recurring Rs. 1·4 lakhs. No new plan has been submitted by the University. The plan described here was submitted for the interim consideration of the Commttee in August, 1947.
3. Agra University (Affiliated college Agra College, Agra.)	For strengthening of Chemistry, Physics, Botany, and Zoology, Post-graduate departments. (Plan submitted for the interim consideration of the Committee).	M.Sc. Ph.D. Chemistry . . . 40 8 Physics . . . 20 4 Botany . . . 20 6 Zoology . . . 20 4 100 22	Capital 4·0 lakhs. Recurring 1·27 lakhs
4. Benares Hindu University.	The University has the following development plans: *Physics.*—Setting up of a mass spectrograph and extending the present line of work in the subject. *Geography.*—Expansion of research facilities for training in geophysical methods of mineral propecting, investigation of ores micro-palaentology in its application to oil prospecting, survey of radio-active minerals, utilization of mineral resources of the country for various industrial purposes. It is also envisaged to double the outturn of post-graduate students. *Geography*—Provision of better equipment and other facilities for teaching and research. *Chemistry.*—Development of research facilities in physical and organic chemistry with a view to catering to a larger number of students at M. Sc. and post M.Sc. stages.	*Geology.* M. Sc. . . . . 12 *Geography.* M. Sc. . . . . 5 Research . . . . 2 *Chemistry.* M. Sc. . . . . 8 Research 6	Capital Rs. 19·08 lakhs. Recurring Rs. 55,600/-. REMARKS: The plan stated in column 2 include under Chemistry the interim plan submitted to the Scientific Man Power Committee in August 1947.
5. Muslim University Aligarh.	The development plan of the University envisages. *Chemistry.*—Starting of a separate research section equipped with pilot plants, etc. *Botany.*—Expansion of teaching and research facilities.	*Maths.* Outturn M. Sc. . . . 6 *Zoology.* Outturn M. Sc. . . . 30	Capital Rs. 7 lakhs. Recurring Rs. 2·2 lakhs.

1	2	3	4
	Maths.—Provision for better facilities for post-graduate teaching and increase in research work and development of mathematical statistics.		
	Geography.—Provision for facilities for study and research in National Planning in its geographical aspect as for example, land utilization, town planning and regional planning, creation of provision for specialisation in some of the more useful branches of geography for example, climatology, development of the Geography Department into a Central Institution for the study of geomorphology and geopolitics.		
6. Lucknow University Lucknow.	The development and expansion programme of the University envisages :	*Increase in intake M.Sc. Courses.*	Capital Rs. 39·32 lakhs. Recurring Rs. 71,000.
	Physics.—Expansion of wireless and spectroscopy sections ; investigation on the manufacture of radio-components, testing of alloys by spectroscopic methods and optical technology.	Chemistry . . . . 12 Physics . . . . 12 Botany . . . . 18 Maths. . . . . 20 Statistics . . . . 20 Zoology . . . . 15 Geology 15	
	Chemistry.—Expansion of research facilities for fundamental research and research on the chemistry of food and Nutrition and Pharmaceuticals, establishment of an institute of bio-chemistry as well as Department of Industrial Chemistry. Increased provision for the training of M.Sc. students.	*Research.* Palaeobotany . . . . 4 Mycology and Plant Pathology. 4	
	Botany.—Institution of a diploma course in plant-pathology and physiology.		
	Zoology.—General expansion of facilities for research in zoological sciences with particular references to Experimental Zoology and experimental Embryology.	Physiology . . . . 2 Morphology . . . . 4 Geology 3	
	Geology.—Carrying out a programme of research on correlation formations by microforssils and heavy minerals Indian glass and ceramic raw materials, Chemical and microforssil analyasis of coal, Geological study of Indian soils including chemical aspects of ore evaluation and prospecting.		
	Mathematics.—Introduction of Astronomy—Practical and Theoretical, Meteorology, Aerodynamics and Aeronautics.		

1	2	3	4
7. Forest Research Institute, Dehra Dun.	A post-war reorganisation scheme of the Institute has been submitted to the Government, the principal objectives of which are to provide sound foundation for schemes for extension of forests, soil conservation, prevention of soil erosion and the better and more extensive use of timber and other forest products. The proposals are designed to revise the scales of pay and to provide additional staff considered necessary to enable the Forest Research Institute to undertake research needed for the post-war plans for Forest Departments and Industries dependent on forest raw materials.	No details regarding the consequential increase in the training facilities.	Capital Rs. 62·78 lakhs. Recurring Rs. 10 lakhs.
8. Khalsa College, Amritsar.	Development of Zoology, Botany, and Agricultural Departments.	No details regarding the consequential increase in the training facilities.	Capital 6·65 lakhs. Recu ring 3·2613 lakhs.

STATEMENT

Increase in the rate of outturn of Scientific Personnel consequent on the Implementation of the Development Plans

Category	Southern Zone	Western Zone	Eastern Zone	Northern Zone	Total
*Bachelor of Science (**Hons.**)**					
Physics	38	No information	No information	No information	38 Only for one zone.
Chemistry	47				47
Botany	40				40
Mathematics	16				16
Zoology	36				36
Geology	20				20
(*3-years, honours course).					
Masters of Science (M. Sc.)					
Physics	27	103	40	39	209
Chemistry	16	113	30	70	229
Mathematics	2	32	24	26	84
Botany	30	50	39	33	152
Zoology	27	35	32	68	162
Geology	12	15	14	27	68
Physiology	..	..	10	..	10
Statistics	5	..	19	20	44
Geography	..	..	13	5	18
Post-graduate Diploma Holders					
Fermentation Technology	10	..	..	..	10
Statistics	30	..	..	..	30
Marine Biology and Fisheries	40	..	..	..	40

Category	Southern Zone	Western Zone	Eastern Zone	Northern Zone	Total
M. Sc. trained specially in					
Physics	..	..	..	20	20
(Thermodynamics and statistical) Mechanics, vacuum technique, applied optics and microwaves.)					
Chemistry	..	..	..	30	30
(Analytical chemistry, micro-organic analysis, pharmaceutical chemistry and biochemistry.					
Biology					
Biological studies in resistance, physiology, genetics, etc.	..	..	..	10	10
Research					
(Additional number of research workers for whom training facilities would be available).					
Physics	30	53	61	10	*Phyiscs* 171
Nuclear Physics	3	..	..	..	....
Low Temperature Physics	4	..	..	..	....
Applied Physics	4	..	..	..	....
Meteorology	6	..	..	..	....
					Chemistry.
Chemistry	6	26	84	18	227
Biochemistry	20	..	..	..	....
Sanitation Chemistry	8	..	..	..	....
Food and Nutrition Research	10	..	..	..	....
Applied chemistry	25	30	..	..	....
Statistics.	10	..	2	..	Statistics 12
Mathematics	..	2	17	..	Maths. 19
Botany	14	7	9	19	Botany 49
Zoology	14	4	7	7	Zoology 32
Applied Biology	12	..	..	..	Applied Biology 12
Geology and Mineral Research	14	15	2	3	Geology 34
Preventive Medicine	6	..	..	..	Preventive Medicine. 6
Marine Biology and Fisheries	12	..	..	..	Fisheries and Marine Biology. 12
Bacteriology	..	3	..	..	Bacteriology 3
Physiology	..	..	4	..	Physiology 4
Geography	..	..	2	..	Geography 2
Leather Technology	..	..	3	..	Leather Technology. 3
Chemical Engineering	..	..	3	..	Chemical Engineering 3

Agricultural Education and Research

9. It is proposed to deal in this section with facilities available in the country for education and research in agricultural sciences. A brief analytical statement is presented in the following on institutions providing facilities for training in agriculture and related subjects as well as on the institutions engaged in research in these subjects. These Statements indicate the nature and scope of activities of the institutions, and the intake and outturn of students for the various courses of study and training.

STATEMENT XI

Institution (1)	Nature and scope of activities (2)	Latest intake (3)	Outturn during 1946-47 (4)	Remarks (5)
Southern Zone—				
Agricultural College, and Research Institute, Coimbatore.	Teaching upto B. Sc. (Ag.) standard ; Post-graduate teaching and research. Research on all aspects of agricultural and allied fields comprising mycology, agricultural chemistry, entomology, oilseeds, millets, fruits, paddy, cotton, agronomy and pulses. The institute is a whole-time research organisation which provides facilities for the training of research workers as well. There is no regular intake for research training but it is understood that the available facilities can be utilised for the training of about 4 candidates in agronomy and plant physiology, 2 in plant-breeding and genetics, 2 in plant pathology, 2 in agricultural chemistry and 3 in horticulture.	B. Sc. (Ag.)— 96	77	
Agricultural College, Bapatla.	Teaching upto B. Sc. (Ag.) and M. Sc. (Ag.) standard	B.Sc. (Ag.)— 96	Nil	The college started functioning only recently and the first batch consisting of 72 students passed out in 1947-48. The institution intends providing facilities for post-graduate training upto M. Sc. standard from 1950 onwards.
Mysore Agricultural College and Research Institute, Bangalore.	Teaching upto the licentiate and degrees standards in agriculture ; Research in agriculture and allied fields. Specialised research on plant-breeding with special reference to the crops of Mysore, control of crop pests ; study and control of crops diseases and general problems of research on agricultural chemistry from the point of view of soil fertility and crop production. There is no regular annual intake of candidates for research training but the available facilities can be utilised for the training of 2 candidates in agronomy and plant physiology, 1 in plant pathology, 1 in entomology, 1 in agricultural chemistry and 2 in horticulture.	Licentiates— 16 Degree Holders— 48	19 Nil	The institution started functioning for degree courses only in 1946.

(1)	(2)	(3)	(4)	(5)
Sugar Cane Institute Coimbatore. Research	A whole-time research organisation run by the Indian Sugar Cane Committee which specialises in research on sugarcane development with special reference to breeding economic types of sugar cane to suit different tracts of India, study of saccharu and related genera, genetics and cytology of sacchrum and related genera, 'plant physiology as applied to sugar cane problems with special reference to the arrowing problem in sugar cane ; studies in flowering in sugar cane irrigation, manuring and influence of the growth promoting substances on the development of sugar cane plant ; chemical composition of cane varieties etc ; and studies in the maturity of sugar cane with a view to enabling factories to work longer. The institute can offer facilities for the training of 2 candidates in plant breeding and genetics upto an advanced stage.			
entral Tobacco **Research Institute.**	The institute was started only an year ago and during the last tobacco growing season it has just made a start in the matter of trying out some of the important varieties collected from all over the world. A very lasge collection of such international varieties is being maintained in the nursery stock for the future programme of extensive work on the genetics of tobacco with special reference to quality tobacco. and also for work in the curing of tobacco. The institute can provide research training facilities for two candidates in plant-breeding and genetics.			
Indian Dairy Research **Institute,** Bangalore	Whole-time research institution for research on all aspects of Dairy Sciences. Dairy husbandry including animal nutrition, dairy technology dairy chemisty, dairy bacteriology and dairy engineering. The Institute also conducts training courses—Diploma stage—for both under-graduates and graduates.			

(1)	(2)	(3)	(4)	(5)
		The intake and outturn are as follows—		
		Intake	*Outturn*	
		Indian Dairy Diploma Course for under-graduates. 26	24	
		Advanced post-graduate course in Dairy Sciences. 18	18	
		Research training . 3	3	
Western Zone—				
College of Agriculture, Poona.	Teaching upto the degree and Post-graduate standards in agriculture and related subjects ; Research in agriculture and allied subjects.	B. Sc. (Ag.) . 241 M. Sc. (Ag.) . 12	98	No particulars have been furnished regarding the details of research carried out at the institution and of the facilities available for the training of research workers.
College of Agriculture, Nagpur.	Teaching upto the degree standard in agriculture.	B. Sc. (Ag.) . 84	41	
Eas tern Zone—				
Institute of Agriculture, Calcutta.	Teaching upto the the degree and post-graduate standards and research in agriculture and related subjects.	Details not furnished	Certificate Holders in Agriculture—3	The institute is in a formative stage and will start degree and post-graduate courses from 1948 onwards. The institute was conducting a certificate course till recently, which will be discontinued from this year.
Bihar Agricultural College, Sabour.	Teaching upto the licentiate, degree and post-graduate standards in agriculture, and research in agricultural sciences.	Not furnished	Licentiates in agriculture—98	The institution started degree course in agriculture recently and the 1st batch of 24 graduates in agriculture has been produced in 1947-48, no details are available regarding the scope and lines of research of the institution nor of the facilities available for the training of research workers. But it is understood that the institution can provide facilities for the training of 16 workers in plant-breeding, soils, entomology, agronomy agricultural economics and horticulture.
..				
Central Inland Fisheries Station, Calcutta.	The research station is being organised for fundamental and applied research on all aspects of inland and esturine fishes. Training facilities for fish chemistry and fish engineering in relation to inland esturine fishes will be available at the station. When fully established, the station will provide a regular course in these subjects as part of the above normal activities.			

(1)	(2)	(3)	(4)	(5)
Central Rice research Institute, Cuttack	whole-time research institution for research on all aspects of paddy cultivation comprising genetics, plant breeding, agronomy, mycology, entomology, statistics, biochemistry and plant-physiology in relation to paddy and rice.			
Botancial Survey of India, Calcutta.	Fundamental research on systematic botany and applied botanical research on plants of economic or industrial use, such as those yielding fibres, dyes, essential oils, starch etc.; identification of crude drugs and advise in respect of economic vegetable resources of India. The organisation maintains an Industrial Section at the Indian Museum and an uptodate Botanical Garden representing a very good collection of foreign and Indian Plants. No details are available regarding the facilities for the training of research workers.			
Central Sericultural Station, Berhampore.	Research on all sapects of sericultural sciences with special reference to mulberry diseases of the silk worm, rearing of indigenous and foreign silk worm breeds etc.			
Institute of Rural Reconstruction, Sriniketan.	Development research on soil conservation and afforestation, rural economic, agriculture, village industries, fisheries and public health. The present intake of research workers for training is 2 per year.			
Northern Zone—				
Government Agricultural College, Cawnpore.	Teaching upto the degree and post-graduate standards in agriculture and related subjects. Research in agricultural sciences.	B. Sc. (Ag.) . 208 M. Sc. in (Ag.) 34	B. Sc. (Ag.) . 83 M. Sc. In (Ag.). 3 Agricultural chemistry. 3 Agricultural Zoology 2 Plant-Physiology. 3 Plant-breeding. 2 Agricultural Economics. . 3	

1	2	3	4	5
Balwant Rajpur College, Agra	Teaching upto the degree and post-graduate standards in agriculture and related subjects.	B. Sc.—120 M. Sc.—12	B. Sc. (Ag.)—110 M. Sc. in Agronomy —12 Agricultural Economics—12 Agricultural Botany —6	
College of Agriculture and Institute of Agricultural Research Benares Hindu University.	Teaching upto degree and post-graduate standards and related subjects ; Research in agriculture and agricultural botany.	B. Sc. (Ag.)—45 M. Sc. (Ag.)—15	M. Sc. (Ag.)—24 M. Sc. (Agricultural Botany)—1	Degree courses in agriculture started only recently and the first batch will come out in 1948. No details regarding the lines of research at the Institute as well as of the research training facilities available have been furnished.
Government Agricultural School, Gorakhpur.	Teaching upto the diploma standard in agriculture.	L. Ag. . 70	L. Ag. . . 60	
Institute of plant Industry, Indore	Teaching upto diploma standard in agriculture and post-graduate research and training in plant-sciences.	Diploma . 9 M. Sc. . 5	Diploma holders in 1947-48—21	
Indian Institute of Agricultural Research, Delhi.	A whole time research organisation for comprehensive research on all aspects of agriculture and related subjects as well as for post-graduate training of students in these subjects. Facilities for fundamental and applied research are available at the institute for such subjects as agronomy, agricultural chemistry, agricultural botany, sugar cane breeding, entomology, mycology and plant pathology. The institute also maintains six sub-stations for various important crops like wheat, sugar cane, potato, and tobacco. The available facilities of the institute are adequate for the training of about 50 research students. At the end of the research training, the institute awards post-graduate diploma During 1946-47 the institute turned out 33 diploma holders in the following Subjects :— Agronomy 9 ; Sugar cane breeding 2 ; Botany 5 ; Chemistry 7 ; Entomology 3 and Mycology 7. The admissions into the various courses during 1947-48 are 49 students.			

1	2	3	4	5
Allahabad Agricultural Institute, Allahabad	Teaching upto the diploma standard in dairying and upto the degree standard in agriculture and agricultural engineering	Indian Diploma—*nil* B. Sc. (Ag.)—30 B. Sc. (Ag.) Engineering—8	 21 16	
Central College of Agriculture, Delhi	Teaching upto B. Sc. (Hons.) Standard in agriculture at present	B. Sc. Hons. (Ag.) 16	*Nil*	The college was started in August 1947 and the first batch will appear for the final examination in 1950. The admissions in the coming years will be much higher than the present intake.
Central Horticultural Research Institute.	The Institute is in the course of establishment under the auspices of the I. C. A. R. and will, when completed, provide training upto diploma standards in Horticulture and for post-graduate research—both basic and applied on all aspects of horticulture.			
Indian Institute of Fruit Technology	The Institute is in the course of establishment and will provide facilities for post-graduate research in fruit technology as well as for training upto diploma standard in fruit preservation.			
Central Potato Research Institute	The Institute is in the course of establishment and will, when complete, carry out basic research on all important aspects of potato cultivation and improvement such as for instance breeding disease resisting varieties, seed certification etc. The institute will also provide facilities for post-graduate research and training of students in these subjects.			
Indian Veterinary Research Institute, Izatnagar	Combined whole-time research and teaching institution. The research work of the institute relates to various aspects of animal chemistry, physiology, pathology, bacteriology, nutrition, genetics, poultry research. parasitology, vaccine and sera production. Advanced post-graduate courses are conducted in the various branches of veterinay sciences at the end of which the candidates are awarded the Associateship of the Institute. The research facilities available are also utilised by research workers, working for research degrees of Indian Universities.			The outturn of candidates trained in various post-graduate courses is 80/year. The institute can also admit 12 research workers for research training in addition to the normal intake of students for the set courses.
Indian Forest College, Dehra Dun	Training for a post-graduate diploma—AIFC in forestry.			The present average anual outturn is about 25 students.

Southern Zone

10. From the above analytical statements on agricultural institutions, it will be observed that in the Southern Zone, facilities for agricultural education are available in three institutions, *viz.*, the Agricultural Colleges in Coimbatore, Bapatla and Bangalore. The first two train candidates upto the degree standard—B.Sc. (Ag.) and their total intake is 192 at present. The Bapatla College was started only recently and the first batch consisting of 72 candidates in agriculture has come out only this year. The establishment of this college in the Madras Presidency is a sequel to the governments decision to produce 1000 graduates in agriculture during the next 5 or 10 years. The Agricultural College at Bangalore provides training both upto the degree and the diploma standards, the former having been started only in 1946.

11. At present, post-graduate training in agricultural sciences is given only at the Agricultural Research Institute, Coimbatore. Graduates in Botany or in agriculture are admitted into the ten research departments of the institute, namely Agricultural Chemistry, Mycology, Paddy, Cotton, Millets, Oilseeds, Agronomy, Horticulture and Sugarcane and trained for a period depending on the nature of problems entrusted to individual candidates. The institute ordinarily provides for about 10—15 candidates at a time but there is no regular intake into any of these research training courses.

12. The chief centres of Agricultural research in the Southern Zone are the Agricultural Research Institute, the Sugar Cane breeding Station and the Central Tobacco Research Institute. The work of the Agricultural Research Institute is carried out through 10 research departments *viz.*, Mycology, Agricultural Chemistry, Entomology, Oilseeds, Millets, Fruits, Paddy, Cotton, Agronomy and Pulses. Each of these departments is manned by a Head of the Department assisted by a number of officers and research asistants. Several temporary research schemes sanctioned by the Indian Council of Agricultural Research are also investigated in these departments. Generally speaking, the research programme of the Institute is of an applied nature and aims at greater agricultural benefit with particular reference to the improvement of variety of crops, effective control of pests and diseases, researches on green manure etc. In the following is given a brief account of the salient features of the research investigations carried out in the various departments.

Mycology.—Work on various problems connected with crop diseases caused by fungi, viruses and bacteria. Artificial production of ergot on a commercial scale has been undertaken for the first time in the country. Conditions for the production of food yeast from molasses on a pilot plant scale have also been studied at the Institute. Cultivation of edible mushrooms has recently been undertaken and a considerable bulk of mushroom spawns has been successfully distributed and introduced in various districts of the province. Cheap devices have also been evolved for growing edible mushrooms.

Agricultural Chemistry.—The work of this section is mainly concerned with soil improvement. Work on minor elements and the manner of reclamation of alkaline region is under-way. Work on manurial and water requirements of paddy, physical conditions of soil and its cultivation is also in progress. Classification and study of soils particularly black soils of new dam projects has been undertaken. One of the interesting items of research is the assessment of nutritive value of seeds in relation to manures. In addition to this, work on animal nutrition is also in progress. This department also supplies legume cultures to the ryots and investigates the various problems connected with agro-industries particularly from the point of view of agar production from seaweeds etc. As a part of the bio-chemical research, investigations are in progress on certain aspects of fruit and vegetable preservation in co-operation with the Fruit Products Research Laboratory at Kodur.

Entomology.—The Entomology Department is mainly concerned with pest control for cultivated crops. This includes not only the trying of well-known insecticides but also work on biological control of pests. A certain amount of developmental research on methods of fumigation of various crops has been in progress. Fundamental studies on the toxonomy of insects are also undertaken.

Oilseeds.—The research programme of this section relates to groundnut, gingelli, cocoanut, cashew-nuts, castor, minor oilseeds, sunflower, mustard etc. with the particular object of breeding better varieties of oilseeds as well as the determinations of the method of cultivation for the better production of oilseeds. Work on seed storage is also an important aspect of research of this division.

Millets.—The Millet Section has been working mainly on the breeding and genetics of better varieties of millets. Work on the anatomy and toxonomy of millets is also undertaken. Hybridization and yield trials of cultivated crops and introduction of mutation by artificial methods are in progress. The breeding programme consists of products of improved millets from the point of view of diseases and draught resistance and for increase in green yields and fodder value. This section also undertakes advanced cytogenetical work on paddy, fruit crops, pulses, vegetables, etc.

Fruits.—The Fruit Specialist of the institute is statined at Kodur where a large experimental farm for research on all aspects of the genetics and breeding of crops has been established. Practically all the important food crops of South India are investigated into at this station. Several regional stations for the study of hill fruits under their environmental conditions are also functioning. The notable feature of this experimental station is the production of a very large number of important mango strains which are capable of greater yields and fruits of better quality. Work on manurial trials on fruit and vegetable yield on statistical basis is also going on at this research station.

Paddy.—The chief aim of this section is the improvement of the rice crop in all its aspects. In tensive research has yielded in the past a number of high yielding strains. These are further being experimented upon and the main research programme consists of hybridization, mutation, genetical and physical studies with particular reference to paddy. A number of sub-stations have been established for the testing of new varieties under different soil and irrigational conditions before they are available for distribution to the cultivators on a mass scale.

Cotton.—This section has evolved a number of long-staple cotton in the past and has thereby helped to increase the acreage under cotton cultivation considerably. Work on all aspects of cotton breeding is carried out on an extensive scale at this section which has been responsible for evolving a number o new varieties of cotton of economic importance.

Agronomy.—Agronomical research consists essentially of agricul tural trials in dry lands,randomised and replicated on a statistical basis where the temperature of the soil is judged by the type and extent of ploughing and is investigated on various crops like maize, cotton etc. Tillage experiments in cotton also on similar lines are underway. Investigations are also being conducted on the correlation of rainfall and yield factors together with methods for eradicating weeds in red soils. The other aspects of research of this section relate to harmone weed-killers and effects of catalysts on cotton as affecting the yield of crop.

Pulses.—The work of this section relates to the improvement of pulses in the province and evolution of new varieties by further breeding experiments particularly from the point of increase in the yield, draught resistance, resistance to disease etc.

13. *Sugar Cane Research Institute.*—Indian sugar cane breeding station. This institute is managed by the Indian Sugar Cane Committee, for research on sugar cane development by intensive programme of research on all aspects of sugar cane plant. The history of the institute is well-known for the immense quantity of practical results that it has given in the annals of Indian Agriculture, and the institute has today helped to establish the Sugar Industry in this country. The following indicates in brief the special lines of investigations at the Institute :

(*a*) Breeding of economic types of sugar cane to suit different tracts of India ; study of *sachharum* and related genera.

(*b*) Genetics and cytology of *sachharum* and related genera.

(*c*) Plant physiology as applied to sugar cane problems with special reference to arrowing problem in sugar cane.

(*d*) Studies on flowering in sugar cane, irrigation, manuring and influence of growth promoting substances on the development of the sugar cane plant, chemical composition of cane varieties, etc.

(*e*) Studies on the maturity of sugar cane with a view to enabling factories work longer.

14. *Central Tobacco Research Institute.*—This institute started functioning only last year. During the last tobacco season, it has been able to make a start trying out some of the important varieties of tobacco collected from all over the world. A large collection of international varieties is being maintained in the Nursery Stock for future programme of extensive research on the genetics of tobacco with special reference to quality tobacco and also on the curing of tobacco.

15. Besides the above whole-time research organisations, research in agriculture in its widest sense is also being carried out in the Botany Departments of Universities and Science Institutions. Botany is one of the sciences fundamental to the development of agriculture and any successful research carried out in this branch of science finds immediate use in agriculture. We have under 'Higher Scientific Education and Research' referred to the research work carried out in botany in the university research centres in the Southern Zone and this undoubtedly forms a significant part of agricultural research carried out in the zone.

16. Special mention must be made here of the Indian Dairy Research Institute at Bangalore which covers all aspects of dairy sciences—dairy husbandry including animal nutrition, dairy technology, dairy chemistry, dairy bacteriology and dairy engineering. The Institute also conducts training courses leading to a diploma in dairy sciences both for undergraduates and post-graduates. Three research workers can also be trained at a time at the Institute.

Western Zone.

17. In the Western Zone, two institutions the College of Agriculture, Poona and the College of Agriculture, Nagpur—teach upto the degree standard in agriculture and their present total outturn is about 140 graduates per year. The intake into these institutions in recent years has increased considerably, as a result of which the number of graduates in agriculture to be produced in the coming years will be much larger. The College of Agriculture, Poona also provides facilities for post-graduate training in agricultural sciences. As regards research, it is stated that facilities are available in both these institutions but no details of the lines of work have been furnished.

Eastern Zone.

Agricultural Education.

18. There are two institutions—the Institute of Agriculture, Calcutta University and the Bihar Agricultural College, Sabour in the Eastern Zone which provide facilities for education in agriculture. At the former, the degree and post-graduate courses are expected to commence from 1948-49. This institution was till recently training students for a certificate course in agriculture which has been discontinued from this year. In the Bihar College of Agriculture, facilities are available for training upto the diploma and the degree standards. The present intake and outturn of students in this institution are furnished in the analytical statement. No details of the research work carried out at either of these institutions are available. Perhaps, little research is at present being carried out.

Agricultural Research.

19. The chief centres of agricultural research in the Eastern Zone are the Central Rice Research Institute, Cuttack, Botanical Survey of India, Calcutta, the Sericultural Station, Berhampore and the Institute of Rural Reconstruction, Sriniketan. The Central Rice Research Institute which has been established recently, covers all aspects of paddy cultivation comprising genetics, plant-breeding, agronomy, mycology, entomology, statistics, biochemistry and plant physiology in relation to paddy or rice. The Botanical Survey of India carries out fundamental research on systematic botany and applied botanical research on plants of economic importance, such as those yielding fibres, dyes, resins, essential oils, starch, etc. Identification of crude drugs and tendering of advice in respect of economic

vegetable sources of India are also included. The organization maintains an Industrial Section in the Indian Museum and an uptodate Botanical Garden representing a very good collection of foreign and Indian plants. Research on all aspects of sericultural sciences with special reference to mulberry diseases of the silk worm, rearing of indigenous and foreign silk worm breeds etc. is the activity of the Central Sericultural Station, Berhampore. The Institude of Rural Reconsttucti on, Sriniketan, although not a research institute in the strict sense of the term, conducts development al research on soil conservation and affroestation, rural economics, agriculture, village industries, fisheries and public health, a wide range of studies indeed. It also provides certain facilities for the training of research workers in all these subjects.

Northern Zone.

20. There are as many as 8 institutions in the Northern Zone for ag ricultural education and research. Of these, 5 institutions provide facilities for training upto the degree standard and two upto the diploma or licentiate standard. One of these institutions—Allahabad Agricultural Institute—also provides facilities for training in dairy sciences upto the diploma standard as well as in agricultural engineering upto the degree standard. Facilities on a considerable scale exist in this zone for post-graduate education in agriculture and allied fields. The Government Agriculture College, Kanpur, the Balwant Rajput College, Agra and the College of Agriculture, Benares Hindu University, offer M. Sc. courses in agriculture, agricultural chemistry, agricultural zoology, economics and related agricultural sciences. The present outturn of M.Sc's. from these institutions is about 74 per year. A number of post-graduate diploma courses, especially in agronomy, sugar cane breeding, botany chemistry, entomology and micology are also offered at the Indian Agricultural Research Institute.

Agricultural Research.

21. The Chief centre of agricultural research in this zone is the Indian Agricultural Research Institute, which is an all-India institution for fundamental and applied research in all aspects of agricultural comprising agronomy, agricultural chemistry, agricultural botany, plant breeding, entomology micology and plant pathology. The Institute also mai ntains 6 sub-stations for investigations on such important crops as wheat, sugarcane, potato, tobacco, etc. A large staff is employed at the Institute for research work.

22. Special mention must be made of the Indian Veterinary Research Institute at Izatnagar which is both a whole-time research and teaching institution. The research work of the institution relates to various aspects of animal chemistry, physiology, pathology, bacteriology, nutrition, animal genetics, poultry research, parasitology and production of vaccine and sera. Advanced post-graduate courses are conducted at the Institute in all the various branches of veterinary sciences at the end of which the candidates are awarded the Associateship of the Institute. The present outturn of such trained candidates from the various post-graduate courses is 80 per year. The Institute can also admit 12 research workers for research training in addition to the normal intake of students for the set courses.

23. The Institute of Plant Industry, Indore, which is also an important research establishment in this zone, has been carrying on research in soil sciences an agricultural chemistry, agricultural statistics, plant breeding and genetics and agronomy. The facilities available at the institute are sometimes utilized for the training of post-graduate research workers.

24. Although no details of the research work carried out at the educational institutions in this zone are available, it is understood that considerable facilities exist for such research at the College of Agriculture, Kanpur and the Balwant Rajput College, Agra.

25. The present rate of outturn of agricultural personnel (based on 1946-47 outturn) and a forecast of the total number of such personnel likely to be produced during the next 5 years are presented zone-wise in the following statements. The forecast is based on the information furnished by the institutions and takes into account the new institutions that have been started recently and the increase in the intake in others.

STATEMENT XII (A)

PRESENT OUTTEUN OF AGRICULTURAL PERSONNEL YEAR (ON THE BASIS OF 46-47 OUTTURN)

Category	Southern zone	Western zone	Northern zone	Eastern zone	Total
Licentiates in agriculture or their equivalents	19	..	81	36	136
Diploma holders in Dairy Sciences	24	..	21	..	45
Graduates in Agriculture	77	139	223	..	339
Graduates in Agrl. Engg.	...	..	8	..	8
Post-graduates in Agriculture.					
M. Sc. in Agrl. Botany	..	..	7	..	M. Scs. in Agricultural Sciences-74
M. Sc. in Agriculture	..	3	27	..	
M. Sc. in Agril. Chemistry	..	..	3	..	
M. Sc. in Agril. Zoology	..	..	2	..	
M. Sc. in Plant Pathology	..	..	3	..	
M. Sc. in Plant Breeding	..	..	2	..	
M. Sc. in Agril. Economics	..	..	15	..	
M. Sc. in Agronomy	..	..	12	..	
Post-graduate Diploma holders in—					
Agronomy	..	..	9	..	Post-graduate diploma holders in Agril. Sciences =33.
Sugarcane breeding	..	..	2	..	
Botany	..	..	5	..	
Chemistry	..	..	7	..	
Entomology	..	..	3	..	
Mycology	..	..	7	..	
Post-graduate in Dairy Sciences	18	..	..	..	18
Post-graduate in Veterinary Sciences	..	..	80	..	80
Post-graduate Diploma holders in Forestry	..	..	25	..	25

STATEMENT XII(B)

TOTAL OUTTURN OF AGRIDULTURAL PERSONNEL DURIEG THE NEXT 5 YEARS (1947-54)

Category	Southern zone	Western zone	Northern zone	Eastern zone	Total
Licentiates	73	..	415	150	638
Diploma holders in Dairy Sciences	120	..	140	..	260
Graduates in Agriculture	795	856	1,680	225	3,556
Graduates in Agricultural Engg.	..	..	90	..	90
M. Scs. in various branches of Agricultural Sciences	6	43	290	100	439
Doctorates in Agricultural Sciences	..	..	18	..	18
Post-graduate Diploma holders in various branches of Agricultural Sciences.	..	..	350	..	350
Post-graduates in Dairy Sciences	90	..	..	..	90
Post-graduates in Veterinary Sciences	..	..	400	..	400
Post-graduate diploma holders in Forestry	..	..	100	..	100

26. No details of the outturn of trained research workers in agricultural sciences are available from individual institutions, nor of the facilities that exist for the training of research workers in each institution. It is, however, understood that all the important agricultural institutions—educational and research—afford facilities for the training of research workers. As a matter of fact in all such institutions in which post-graduate course in agricultural and allied sciences are offered, research work is an intergral part of the courses. In the above statements we have indicated the outturn of post-graduates in each zone. It may be assumed that this corresponds to a considerable part of the total number of research workers that may be trained in the institutions in that zone. In the following statement is given an approximate estimate of the research training facilities available.

STATEMENT XII(C)

Field of research training.	No. of research workers for whom training facilities are available				
	Southern zone	Western zone	Eastern zone	Northern zone	Total
Agricultural Sciences	26	15	25	100	166
Dairy Sciences	5	..	..	..	5
Veterinary Sciences	..	..	..	12	12

Development and Expansion

91. The development and expansion plans of such of the institutions as have furnished details in this respect are described in brief in the following statements with particular reference to the objectives of the plan, consequential increase in the intake and outturn of personnel and the financial implications

STATEMENT XIII

Institution	Objectives of the plan	Consequential increase in the intake or outturn	Financial implications
1	2	3	4
1. Agricultural College and Research Institute, Coimbatore.	The research development plan of the institute comprises—*Chemistry*: Analysis of soils and manures on a large scale; improvement of equipment and staff facilities for the study of minor elements and their role in plant growth; Oilseeds: Survey of oilseed—bearing plants of India; *Agriculture*: Fundamental studies in crop rotation; manurial and cultural aspects of all food and cash crops; *Entomology*: Extension of plant protection staff for the districts and fundamental research on crop pests, stores products etc.; *Millets*: Increased seed production, opening of sub-stations, large hybridization schemes for evolving resistant strains of sorghum; *Biochemistry*: Opening of a fruit technology institute for advance research both fundamental and applied on fruits and vegetable products; investigations on the establishment of malt industry; *Paddy*: Establishment of more rice research substations; general intensification of fundamental and applied research on the paddy crop; *Mycology*: Establishment of regional stations for photo-pathological research, intensification of research on industrial mycology.	No increase in the intake for the degree courses is envisaged about as a result of the expanded research facilities double the present number of research students can be admitted for training in all the 10 sections, that is to say, 20 more research students can be trained in the research sections.	Capital—Rs. 13 lakhs. Recurring—Rs. 2·3 lakhs. It appears that the whole of the above grant will be have to be met by the Central Government.

1	2	3	4
2. Indian Sugarcane Breeding Station, Coimbatore.	*Cane Breeding.*—The research development plan of the institute comprises breeding and selection of economic types; evolution of various species of Sachharum to serve as parents in cane breeding; technique including Pollen viability and seed germination. *Cyto-genetics.*—Fundamental genetic studies including interspecific and intergeneric hybrids; study of chromozomes of Sachharum and allied genera and cytological basis of male and self-sterlity in cane; the cytogenetics of interspecific and intergenetic hybirds of sugarcane and studies in specialisction and evaluation of cultivate Sugarcane. *Botany.*—Taxomony of sugarcane and allied genera after obtaining collection from *spontaneum* expedition; description and indentification of sugarcane varieties; anatomical studies of sugarcane and allied genera; maintenance of live herbarium. *Plant Physiology.*—Plant physiological investigations on flowering of sugarcane and allied genera with particular reference to photoperiodic and other treatments for inducing and maniuplating flower period C/N ratio of flowering and non-flowering varieties of canes. *Chemistry.*—Analysis of sugarcane seedling for selection; chemical analysis of selected seedlings with reference to manufacturing qualities of Coimbatore canes as a guide in breeding. *Mycology.*—Breeding resistant varieties, etc. *Entomology.*—Breeding of pest-resistant varieties; study of incidence of pest on seedling varieties. *Statistics.*—Advice on the planning of experiments on statistical basis.	The research programme represents the normal development of research activities of the institutions and does not contemplate increasing the intake for research training. But two more research workers can be trained as a result of the expanded facilities.	**Capital—Rs. 6 lakhs. Recurring—Rs. 2 lakhs. It is likely that part of the above grants might be met by the Indian Central Sugar Committee.**
3 Central Tobacco Research Station, Rajahmundry.	*Agronomy.*—Long range experiments like rotation and relationship of non-tobacco crop and tobacco with respect to yield and quality of crops. Influence of non-tobacco crops on fertility status of the soil. Genetic classification of tobacco soils and soil amendment practices. Cultivation practices including fertilisation of nurseries and relationship of micro and macro-climates correlated with the tobacco plant. Setting up of a small meteorological laboratory. *Cytology, Genetics and Nutrition of the Tobacco Plant.*—Investigations of cytogenetical problems with reference to inheritance of species and chromosome behaviour. *Chemical Investigations.*—Chemical composition of various species of tobacco. Fundamental studies on chemical composition of nicotine, etc. Basic work which will show the importance of breeding in curing processes of tobacco in storage. Soil studies with regard to distribution of fertilisers and utilisation and its effect on the soil structure and plant response.	Consequent on the implemention of the research programme 6 research workers can be trained in Agronomy and Cytogenetics.	**Capital—Rs. 10 lakhs. Recurring—Rs. 1 lakh. The Indian Central Tobacco Committee has already voted the necessary grants for the development projects. For research training, however, it may be necessary to institute Fellowships.**

1	2	3	4
	Plant Pathological Investigations.—Fundamental work on " damping of diseases " root wilt diseases: Orabanche parasite: plant virus disease in relation to tobacco.		
	Entomological Investigations.—Work on cut worm pests of tobacco and their control. Statistical Investigations: Studies in the sampling of field and laboratory work, particulary in grading, genetical studies of quantitative characters. Studies of entomological problems with respect to insect populations.		
	Engineering Investigations.—Construction of barns and better utilisation of heat. Temperature and humidity determination in the barn. Studies on different fuels to be used in barn curing technique, electricity, oil fuel, paddy husks, etc.		
	Pedology and its application.—Genetic classification of soils in relation to tobacco growing.		
4. Central Sericultural Research Station, Barhampore.	Establishment of a College of Sericulture on all-India basis for the training of students upto the degree standard in Sericultural Sciences; establishment of 8 sub-stations in different parts of India for carrying out zonal study in sericulture, and of 4 scientific sections for their main stations.	Provision will be made for the training of 10 additional research students.	Capital—Rs. 2 lakhs Recurring—Rs. 50·5 lakhs. Only for the training of research workers.
5. Indian Dairy Research Institute, Bangalore.	The programme of research formulated by Professor Kay to be carried out at the proposed Central Diary Research Institute is understood to be receiving the consideration of the Ministry of Agriculture. No details of this research programme, have been furnished. It is, however, understood that the objectives of the development plan are: to establish a 1st Class Central Diary Research and Training Institute for both fundamental and applied research in dairy sciences and for the training of technical personnel; dairy development work in co-operation with the provincial dairy departments including milk marketing board; to set up a College of Dairying for training upto B. Sc. & M. Sc. degree standards and to promote dairy industry on scientific lines.	No details.	No details.
6. Royal Botanic Gardens, Sibpur, Howrah. Botanical Survey of India.	The scheme for the training of students in systematic botany, horticulture, collection and cultivation of medicinal plants is said to be under the consideration of the Government of West Bengal and the Government of India but no details of the scheme have been furnished.	It is stated that every year 5 candidates will be trained.	Capital Rs. 2 lakhs. Recurring Rs. 25 lakhs. Only for the training programme.

(1)	(2)	(3)	(4)
7. Insitutute of Rural Reconstruction, Sriniketan.	Dissemination of knowledge and experience earned towards the building of village life through the training institute in rural reconstruction with facilities for training 25 students for a 2-year course and refresher course not exceeding 3 weeks ; improvements of agricultural methods and practice ; improvement of the technique of agriculture and animal husbandry with a view to evolving a proper crop policy ; reorganisation and expansion of facilities for research in soil sciences including soil erosion and afforestation.	6 research workers.	Capital—Rs. 2 lakhs, Recurring: Rs. 25 lakhs. For research training.
8. Bihar Agricultural College, Sabour.	Expansion and development of the existing facilities to increase the admission into degree courses by about 60 ; expansion of research facilities for plant breeding soil sciences, agricultural economics, agronomy, entomology and horticulture.	*Increase in the intake* :— Degree courses =60 Research workers =16	Capital—*Rs.* 7·16 lakhs. Recurring—Rs. 4·05 lakhs for the whole of the development & Capital—Rs. 3 lakhs. Recurring—Rs. 70·75 lakhs for the research training programme.
9. Central Rice Research Institute, Cuttack.	Fundamental research on rice including genetics and plant breeding, micology. entomology, statistics, biochemistry and plant physiology.	Additional intake for research training . =10	Capital—Rs. 25 lakhs. Recurring—Rs. 4 lakhs. for the entire development plan & Capital—Rs. 2 lakhs. Recurring—Rs. 0·5 lakhs for the research training.
10. Government Agricultural College, Kanpur.	The development and expansion programme of the institution envisages (*a*) Development research connected with agricultural produce covering various practical aspects such as crop in relation to manuring quality, malting qualities of cereals, malting qualitie of food crops, food storage fodder production and its conservation, nutritional value of different fodders, soil conservation and reclamation, study of soil microflora, agricultural statistics and statistical examination of data ; (*b*) Agrilcultural botany covering physiology of crop plants, physiology of medicinal plants, ecology, botanical survey of the province, study of the vegetation from ecological point of view, study of soils. (*c*) Agricultural Zoology covering plant parasitic nematodes, insecticides of indigenous vegetable origin, sericulture and common silkworm disease in U.P. ecological study with a view to forecasting the insect pest epidemics and practical methods of insect control as applicable to Indian conditions with particular reference to the U.P.; (*d*) Agricltural economics and farmcost studies ; agricultural economic survey of each district and each agricultural region; (*e*) Agriculture covering agricultural engineering, agricultural implements and agronomy; (*f*) Dairying and animal husbandry section covering composition of milk of Sohiwal cows and Murrah buffaloes, different methods of production of butter and ghee and scientific feeding of different cattle at the dairy farm.	*Incrrase intintake* : M. Sc. in Agril : Chemistry =13. M. S.c in Agril Botany =9 M. Sc. in Agril: Zoology =45 M.Sc. in Agril. Economics =12 Ph. D. in Agril ; Economics. =2 M. Sc. in Agril. engineering =5 M. Sc. in Agronomy =5 Diploma in Dairy Sciences =20 Short-term course in dairying =160	Capital—Rs. 5·21 lakhs. Recurring—Rs. 2·77 lakhs.

1	2	3	4
11. Indian Veterinary Research Institute.	The main features of the expansion and development project drawn up in 1945 and submitted to the Government are as follows :— (*a*) to modernise the existing arrangements for the manufacture of biological products and to set up a standards laboratory ; (*b*) to enlarge the existing facilities for post-graduate training in different branches of veterinary sciences and animal husbandry by improving the existing courses and instituting new courses ; (*c*) to provide proper hostel accommodation and amenities to students ; (*d*) to strengthen and expand the activities of the research section so as to make good the existing deficiencies and cover certain subjects, for example pharmacology for research in which facilities do not exist at present ; (*e*) to arrange for the proper utilization of the military poultary farm at Izatnagar recently taken over by the institute ; (*f*) to institute all-India egg-laying trials for encouraging the breeding of high lying varieties of poultry ; (*g*) to take over a part of the normal work of the institute certain schemes of research at present financed by the I.C.A.R. The whole scheme is under revision in the light of new developments and existing circumstances.	100% increase in the intake of students into the various courses is possible as a result of the general expansion. At the same time 2 research workers in each of the 6 research sections can be admitted for training without any additional commitments.	Capital—Rs. 48·92 lakhs. Recurring—Rs. 8·2 lakhs. These estimates are under revision in the light of the existing circumstances.
12. Balwant Rajput College, Agra.	The objectives of the plan, are to build a new agricultural college at Bichpuri—7 miles from Agra, for degree standard and post-graduate training in all branches of agricultural sciences. This is the long-term programme. A short-term programme envisaging improvement in the existing facilities with a view to stepping up the standard of training has also been proposed.	No details.	*For the short-term programme.* Rs. 83,000 (both capital & recruiting) *For the long-term Programme.* Capital—Rs. 16.42 lakhs. Recurring–Rs. Not stated. The U.P. Government has given the lease of the Government Farm at Bichpuri and has advanced a loan of Rs. 2 lakhs for acquiring additional land the college needs for its purpose from other sources. The Principal has requested the Central Government to meet at least a portion of the remaining funds required. The long-term project covers development of post-graduate education also in Chemistry and Zoology.

(1)	(2)	(3)	(4)
13. Indian Agricultural Research Institute, Delhi.	General expansion of the Research Divisions of the Institute and the establishment of 3 new divisions: Agricultural Engineering ; Agricultural Economics and Agricultural Statistics— for the development of research and training of personnel in these branches also ; Institution of advanced research and training in soil survey, soil erosion and soil conservation and biochemistry and nutrition study of crop and fodder in relation to soils ; Starting of 2-year post-graduate diploma courses in cytology, physiology, economic botany, entomology, toxicology and ecology.	50 more post-graduate students are expectod to be trained every year.	*Capital* : Rs. 41 lakhs. *Recurring* : Rs. 20 lakhs. The above excludes the cost of residential buildings.
14. Indian Institute of Fruit Technology.	The Institute is being re-established in the Indian Union and will, when completed, cover all aspects of scientific and industrial research on the science of fruit and vegetable preservation, development and standardisation of methods of preparation of preserved fruits and vegetables testing and certification and to promote, through scientific and technical advice and research fruit preservation and canning industry. It will also conduct a 2-year diploma course in vegetable and fruit preservatoion.	No details	No details.
5. Potato Research Institute	The institution is under establishment and will, when completed, provide facilities for training in all subjects relating to potato improvement work in addition to carrying out comprehensive research on potato cultivation.	No details.	No details.
6. Allahabad Agricultural Institute, Allahabad	Development of the Institute particularly with a view to increasing the strength of the staff in order to cater for additional number of students and for conducting research ; creation of a department of rural sociology and construction of buildings necessary for a student body of 500.	*Additioanal intake* B. Sc. in Agri. =90 B. Sc. in Agril. Engineering=40 Indian Dairy Diploma =50	*Capital* : Rs. 8 lakh *Recurring* : Rs. 7·4 lakhss The above grants are essential for the development of agricultural education and research.
17. Institute of Plant Industry, Indore	It is contemplated to start a college of Agriculture after a period of about 8 years.	No details.	No correct informatio has been furnished.
18. Agricultural College & Research Institute, Benaras Hindu University.	Full development of the institution for training upto degree and post-graduate standards for research in all branches of agricultural sciences. Increase in the outturn of personnel is also envisaged.	*Increase in outturn* B. Sc. (Ag) =50 M. Sc. in Agril. Sciences -35	*Capital* : Rs. 32 lakhs. *Recurring* : Rs. 5 lakhs Funds have to be provided by the Government of India.
19. Utkal University	For establishing a new Agricultural college for establishing a new Veterinary College	B. Sc. (Ag)=20 Diploma holders=40 Degree courses =20 Diplomaholders=40	*Capital* : Rsl. 7·5 lakhs *Recurring* : Rs. 7·5 lakhs. *Capital* : Rs. 7·5 lakhs. *Recurring* : Rs. 1·5 lakhs.

Southern Zone

27. From the above statements on the development plans of the various institutions in the Southern Zone, it will be observed that no increase in the intake for the degree or other regular courses has been envisaged by the institutions. The plans relate chiefly to the development of research in agriculture and allied fields, and will on implementation provide additional facilities for the training of more research workers. These facilities have been expressed in the analytical statements in term of the number of research workers that might be trained. The research development plan of the Agricultural Research Institute, Coimbatore, comprises :

Chemistry : Analysis of soils and manures on a large scale and comprehensive study ef the role of minor elements in plant growth.

Oilseeds : Survey of oilseeds-bearing plants of India.

Agriculture : Fundamental studies in crop rotation and manurial and cultural aspects of all food and cash crops.

Entomology : Extension of plant protection measures to the districts and fundamental research on crop pests, stored products etc.

Millets : Increased seed production, opening of sub-stations, large hybridization schemes for evolving resistant strains of sorghum.

Biochemistry : Starting of fruit technological and applied on fruits on the establishment of malt industry.

Paddy : Establishment of more rice research sub-stations and general intensification of fundamental and applied research on the 'paddy crop.

Mycology : Establishment of more regional stations for Phytopathological research and the intensification of research on industrial mycology.

28. The research development plan of the Indian sugarcane breeding station comprises breeding and selection of economic types, evaluation of various species of sachharum and studies in cane breeding technique including pollen viability and seed germination. In the field of cytogenetics, it is contemplated to carry out fundamental genetic studies including interspecific and intergeneric hybrids ,study in the chromosomes of sachharum and allied genera and cytological basis of male and self steriity in cane The cytogenetics of interspecific and intergeneric hybrids of sugar-cane as well as speciation and evaluation of cultivated sugarcane are also contemplated. In the field of agricultural botany, studies on the taxonomy of sugarcane and allied genera after obtaining collection from spontoaneum expedition have been planned.Other aspects of research in the same field relate to identification of sugarcane variet ies anatomical studies of sugarcane and allied genera and maintenance of live herberum. In the plant physiology section, it is contemplated to carry out physiological investigations on flowering of sugarcane and allied genera with particular reference to photoperiodic and other treatments for inducing and manipulating flower period. Analysis of sugarcane of selected seedlings with reference to manufacturing qualities of Coimbatore cane as a guide in breeding from the research programme in mycology, entomology and statistics sections.

29 The Central Tobacco Research Station has a comprehensive programme of research on tobacco crop with special reference to studies on the rotation and relationship of non-tobacco crop and tobacco crop with respect to yield and quality of crops, influence of non-tobacco crops on fertility status of the soil, genetic classification of tobacco soils and soil amendment practices, cultivation practices including fertilisation of nurseries and relationship of micro and microclimates corelated with the tobacco plant ; cytology, genetics and nutrition of tobacco plant, chemical composition of various species of tobacco, basic studies bearing on breeding in relation to chemical composition, chemical curing of tobacco in storage soil studies with regard to distribution of fertilisers and utilisation and their effect on the soil structure and plant response; plant pathological and entomological investigations on the diseases of the tobacco-plant and engineering investigations on the construction of barnsand other aspects of tobacco curing.

30. A plan for the development of the Indian Dairy Research Institute is stated to have been prepared by Prof. Kay for the cousideration of the Government of India, but no details of the plan have been furnished. It is, however, understood that the objectives of the development plan are to establish a first class Central Dairy Research and Training Institute for both fundamental and applied research in dairy science and for the training cf technical personnel, dairy development work in co-operation with the Provincial Dairy Departments including Marketing Board, setting up of a College of Dairying for training upto B.Sc. and M. Sc. degree standards and to promote dairy industry on scientific lines.

WESTERN ZONE

31. Institutions in the Western Zone have not furnished any development plans—educational or research.

EASTERN ZONE

32. The only development plan relating to increase in the outturn of agricultural personnel is that of the Bihar College of Agriculture, Sabour, which envisages expansion of the existing facilities at the nstitution with a view to increasing the admission into degree courses by about 60 students. All the research institutions in this zone have plans for the development of research in agricultural and allied sciences which briefly are as follows :

Central Sericultural Research Station, Berhampore

33. Establishment of a College of Agriculture on an All-India basis for the training of students upto the degree standard in sericultural sciences and the establishment of 8 sub-stations in different parts of India for carrying out zonal study in sericulture. No details of the proposed College of Agriculture have, however, been furnished.

Royal Botanis Gardens, Sibpur, Howrah

34. A scheme for the training of research students in systematic botany, horticulture collection and cultivation of medicinal plants is said to have been drawn up and is under the consideration of the Government of India. No details of the plan, however, have been furnished.

Institute of Rural Reconstruction, Sriniketan

35. Dissemination of knowledge and experience earned towards the huilding of village life through the training Institute in rural reconstruction with facilities for training 25 students for a 2-year course ; improvement of agricultural methods and practice ; improvement of the technique of agriculture and animal husbandry with a view to evolving a proper crop policy ; reorganization and expansion of facilities for research in soil sciences including soil conservation, prevention and erosion and afforestation.

Bihar Agricultural College, Sabour

36. Expansion of facilities for research in plant breeding, soil sciences, agricultural economic, agronomy, entomology and horticulture.

Central Rice Research Institute, Cuttack

37. Fundamental research bearing on rice including genetics and plant breeding, mycology, entomology, statistics, biochemistry and plant physiology.

NORTHERN ZONE

38. All the educational institutions in this zone have plans for the development of research in agricultural sciences with consequential increase in the facilities for the training of post-graduates students. The development programme of the Government Agricultural College, Kanpur, envisages :

(*a*) Development of research connected with agricultural produce covering various practical aspects such as crop in relation to manuring quality, malting qualities of cereals and food crops, food storage, fodder production and its conservation, nutritional value of different fodders, soil conservation and reclamation, study of soil microflora and statistical examination of agricultural data ;

(*b*) Research in agricultural botany comprising physiology of crop plants and medicinal plants, ecology and botanicalsurvey of the province, study of the vegetation from a ecological point of view, study of soils etc.

(*c*) Research in agricultural zoology covering plant parasitic nematodes, insecticides of indigenous vegetable origin, sericulture and common silk worm diseases in U. P., ecological study with a view to forecasting the insect pests epidemics and practical methods of insect pests control as applicable to Indian conditions and with particular reference to the U. P.

(*d*) Studies in agricultural economics and farmcosts, agricultural economic survey of each district and each agricultural region.

(*e*) Research in agriculture including agricultural engineering, agricultural implements and agronomy.

(*f*) Research in dairying and animal husbandry relating to composition of milk of various breeds of cows and buffaloes, different methods of production of butter and ghee and scientific feeding of cattle at the dairy farm etc. As a result of these research development plants, the intake into the M. Sc. course in the various branches of agricultural sciences will increase by about 90. It is also contemplated by the institute to introduce a diploma course in dairy sciences with an intake of 20 students.

39. The Balwant Rajput College, Agra, has a long-range plan, the object of which is to build a new Agricultural College at Bichpuri about 7 miles from Agra for degree standard and post-graduate training in all branches of agricultural sciences. Full details of the plan have not been furnished, but it is understood that the U. P. Government have allotted necessary land for the proposed institution and have also sanctioned a certain capital grant. A short-term programme has also been proposed by the institution for the improvement in the existing facilities with a view to improving the standard of training.

40. The development plan of the Agricultural Institute, Allahabad, relates to strengthening the facilities by way of staff, equipment and accommodation to cater for a larger student body both in the B.Sc. (Ag) and B.Sc. (Ag. Eng.) curse ass well as for research. Creation of a Department of Rural Sociology is also envisaged.

41. Full development of the Agricultural College and Research Institute, Benares Hindu University for training upto degree and post-graduate standards and for research has been envisaged in the development plan of the institution. The consequential increase in the outturn is expected to be 50 graduates in agriculture and 35 post-graduates or M. Sc's in various branches of agricultural sciences.

42. All the research institutions in the zone—Indian Agricultural Research Institute, Indian Veterinary Research Institute, Indian Institute of fruit Technology etc.— have long-term plans for the development of research , which on implementation would result in enhanced facilities for post-graduate training at the institutions. The Indian Agricultural Research Institute has proposed general expansion of all the Research Divisions as well as the establishment of new divisions namely, Agricultural Engineering—Agricultural Economics and Agricultural Statistics-for research and training of personnel in these branches. Promotion of advanced research and training in soil survey, soil erosion and soil conservation and bio-chemistry and nutrition study of crop and fodder in relation to soils is also included in the development programme. A two year post-graduate diploma course in cytology, physiology, economic botany, entomology , tioxicology and ecology has been proposed in addition to the existing courses. Consequent on the implementation of these development plans, 50 more post-graduate students are expected to be trained every year.

43. The main features of the development project of the Indian Veterinary Research Institute are—

(*a*) to modernise the existing arrangements for the manufacture of biological products and to set up a standards laboratory ;

(*b*) to enlarge the existing facilities for post-graduate training in different branches of veterinary sciences and animal husbandry by improving the existing courses and instituting new ones ;

(*c*) to strengthen and expand the activities of the research section so as to make good the existing deficiencies and cover certain subjects, for example, pharmacology for research in which facilities do not exist at present; and

(*d*) to take over as part of the normal work of the institute, certain schemes of research financed at present by the I. C. A. R.

It is understood that the above scheme which was prepared in 1945 is under revision in the light of the new developments and prevailing conditions.

44. As regards the Indian Institute of Fruit Technology, the institute is being re-established in the Indian Union and will, when completed, cover all aspects of scientific and industrial research bearing on the science of fruit and vegetable preservation, development and standardization of methods of preparation of preserved fruits and vegetables, testing and certification and promotion through scientific and technical advice and research of fruit preservation and canning industry. It is also contemplated to conduct at the institute a two year diploma course in vegetable and fruit preservation.

45. The Potato Research Institute which is in a formative stage at present will be completed during the next five year period and comprehensive reseach on potato cultivation as well as the training of personnel in all aspects of potato improvement work will be undertaken.

46. In the following statement an estimate is given of the increase in the outturn of trained agritcultural personnel consequent on the implementation of the development projects. An attempt is also made in the statement to show any increase in the facilities for the training of research personnel in the various research institutions.

STATEMENT XIV

Increase in the outturn of personnel conequencte on the implementation of the Development plants.

Category	Southern zone	Western zone	Eastern zone	Northern zone	Total	Remarks
Diploma in Dairy Sciences . .				70	70	*It is to be noted that this number includes post-graduates under training for MSc. and other post-graduates diplomas in special branches of agricultaral sciences.
Graduates in Agriculture . .			45	120	165	
Graduates in Agricultural Engineering.				30	30	
M.Sc. in various branches of Agri-M. cultural sciences.				120	120	
M.Sc. in Agricultural Engineering .				5	5	
Post-graduate diploma holders in various branches of agricultural sciences.				50	50	
Post-graduates diploma holders in veterinary sciences				80	80	
Rural Reconstruction . . .			25		25	
*Research Training.**						
(Additional number of research workers for whom training facilities would be available) Agricultural Sciencesw	28		30	115	145	
Sericulture			10		10	
Veterinary				12	12	

MEDICAL EDUCATION AND RESEARCH

47. It is proposed to deal in this section with facilities available for medical education and research. For the sake of convenience, the institutions providing such facilities have been broadly classified into :—

(a) Institutions providing for post graduate training and research in medical and allied science.
(b) Institutions providing facilities for training upto the degree standard.
(c) Institutions providing for lower education up to licentiate or diploma standard.

48. In the following statements are given particulars of institutions under the above 3 categories with reference to the subject or subjects taught, degrees or diplomas awarded, the latest figures for in take and outturn etc.

POST-GRADUATE TRAINING AND RESEARCH

49. It is to be admitted at the outset that the facilities available for post-graduate training and research in medical and allied branches are inadequate. Nine medical colleges are stated to provide facilities for such training but considered in the light of the outturn of trained personnel every year, we are unable to say whether the claims of most of these institutions are justified or not. There is no regularity in the intake and outturn of students to and from post-graduate courses in medicine and surgery, viz., for M.S. and M.D. degrees, However. based on the information furnished by the institutions which are analysed in Statement XV, a brief review of the zone-wise facilities it is given.

STATEMENT XV.

Institutions catering for graduate courses in medicine and surgery (M.B.B.S. degree).

Institution.	Latest intake (1947-48)	Outturn	Remarks.
Northern Zone.—			
1. King Georges Medical College, Lucknow	75	54	
2. Agra Medical College, Agra	50	54	
3. Glancy Medical College, Amritsar	60	45	
4. Swai Man Singh Medical College, Jaipur	60	..	The Institution was started in 1947.
5. Gwalior Medical College, Gwalior	40	..	The Institution was started in 1947
6. Indore Medical College	61	..	The Institution was started in 1947.
7. Lady Hardinge Medical College, New Delhi	40	30	
Eastern Zone.—			
1. Carmichael Medical College, Calcutta	129	111	
2. Medical College, Calcutta	225	126	The Institution has introduced Double Shift System.
3. Medical College, Patna	80	59	Condensed 2-years course for 136 licentiates is conducted.
4. Orissa Medical College, Cuttack	22	..	The Institution was started in 1944.
5. Assam Medical College, Dibrugarh	65	..	The Institution was started in 1947.
Southern Zone—			
1. Madras Medical College, Madras	125	88	The Institution has introduced Double Shift, System.
2. Stanley Medical College, Madras	72	20	
3. Andhra Medical College, Vizag.	55	40	
4. Christian Medical College, Vellore, North Arcot	27	20	
5. Medical College, Mysore	50	23	
6. Guntur Medical College, Guntur	50	..	The Institution was started in 1946.
7. Madura Medical College, Madura	50	..	The Institution was started in 1946.
Western Zone.—			
1. G. S. Medical College, Bombay	100	85	
2. Grant Medical College, Bombay	151	117	
3. B. J. Poona Medical School	50	..	The Institution was started in 1946.
4. Ahmedabad Medical School, Ahmedabad	50	..	The Institution was started in 1946.
5. Nagpur Medical College, Nagpur	116	..	The Institution was started in 1947.

50. In the Southern Zone, only two institutions—Madras Medical College and the Andhra Medical College—offer facilities for post-graduate training in medicine, surgery (M.S. & M.D.) and allied branches. The former specially provides for instruction in Pharmacy and Sanitary sciences, Ophthalmology, Gynaecology and Obstetrics, Oto-laryngology and T.B. and clinical laboratory sciences. The Andhra Medical College, Vizag., also provides facilities for advanced instruction in anatomy, physiology, bacteriology, bio-chemistry, pathology, gynaecology and obstetrics and oto-laryngology in addition to medicine and surgery in the Western zone two institutions namely G.S. Medical College and Grant Medical College, both in Bombay provide facilities for post-graduate training in medicine, surgery, gynaecology and obstetrics and ophthalmology. The latter in addition provides facilities for dentistry and T.B. *In the Eastern Zone* there are two institutions - Carmichael Medical College and the Calcutta Medical College - providing facilities for advanced instruction in medicine and surgery. *In the Northern Zone* there are two institutions - K.G. Medical College, Lucknow, Medical College, Agra, and Glancy Medical College Amritsar - providing facilities for advanced instruction in medicine and surgery. Ophthal mology, Radiology and Pathology are also provided for in one of the institutions.

Institutions Catering for Post graduate courses and Reserach

Institution	Subjects.	Degrees or Diplomas awarded	Latest intake	Outturn
Northern Zone—				
1. K. G. Medical College, Lucknow.	Medicine & allied subjects.	M. D.		7
	Surgery & allied subjects	M. S.		
	Radiology. Opthalmology.	D.M.R.E.	34	3
	Pathoogy.	Diploma in Pathology		
2. Agra Medical College, Agra .	Medicine	M. D.	No information.	
	Surgery & allied subjects	M.S.		
3. Glancy Medical College, Amritsar	Medicine & Pathology	M.D.,	3	1
	Surgery and allied subjects.	M. S.	7	..
	Opthalmology.	Dlipoma in Ophthalmology	..	..
Eastern Zone.—				
1. Carmichael Medical College, Calcutta	Medicine and allied subjects	M.D.	No information	
	Surgery	M.S.		
	Ophthalmology	M. O.		
		D.Sc.		
2. Medical College, Calcutta .	Medicine and allied subjects	M.D.	No information	
	Surgery and allied subjects	M.S.		
3. Scoll of Tropical Medicine	Tropical Medicine	D.T.M.	71	66
	Tropical Medicine	L.T.M.	24	20
4. All India Institute of Public Health and Hygiene.	Ref. to details given inside the Report.			
5. Malaria Institute of India .	Re.to details given inside the Report.			
6 .King Institute, Guindy .	Training of medical officers in Blood Bank work—intake 36 ; Training of medical officers and Science graduates in bacteriology-intake 20 ; Training of laboratory technicians and attenders in conjunction with medical colleges, Hospitals etc.—intake 20.			
Southern Zone.—				
1 Madras Medical College, Madras.	Medicine and allied subjects	M.D.	13	3
	Surgery and allied subjects	M.S.	13	4
	Pharmacology	B.Sc. (Pharmacy)	21	10
	Public Health	B.S.c. (Sanitary Science)	1	..
	Ophthalmology	D.O.	6	3
	Gynecology	D.G.O.	10	6
	Oto-laryngology .	D.L.O.	9	5
	Tuberculosis	T.D.D.	...	24
	Clinical Laboratory Sciences	D.L.Sc.	3	3
		Diploma in Nursing & Pharmacy.	..	..

Institution	Subjects.	Degrees or Diplomas Awarded	Latest intake	Outturn
2. Andhra Medical College, Vizag.	Medicine and allied subjects	M.D.		
	Surgery and allied subjects	M.S.		
	Anatomy	M.Sc. in Anatomy		
	Physiology	Physiology		No Information
	Bacteriology	Bacteriology		
	Biochemistry	Biochemistry		
	Pathology	Pathology		
	Gynecology	D.G.O.	1	
	Oto-laryngology	D.L.O.		
Western Zone.—			1	
1. G. S. Medical College, Bombay.	Medicine and allied subjects	M.D.		
	Surgery and allied subjects	M.S.		
	Gynecology and Obstetrics	D.G.O.	No information.	
	Ophthalmology	D.O.		
2. Grant Medical College, Bombay	Medicine and allied subjects	M.D.	8	
	Surgery and allied subjects	M.S.	4	
	Dentistry	B.D.S.		
	Oto-laryngology	D.L.O.	No information.	
	Tuberculosis	T.D.D.		
	Ophthalmology			

Public Health & Hygiene, preventive Medicine and Malariology.

51. Special mention must be made here of the post-graduate training and research facilities available at the All India Institute of Public Health & Hygiene, the Central Research Institute, Kasauli, the Pasteur Institute, Coonoor, the King Institute of Preventive Medicine, Guindy, the Malaria Institute of India and the School of Tropical Medicines as well as their activities which would cover the subject of Public Health & Hygiene, Preventive Medicine and malariology. The All India Institute of Public Health & Hygiene offers courses in Public Health, Maternity and Child Welfare and aims at becoming ultimately the foremost centre for advanced instruction and research in the methods of preventive and social medicine. The Institute is affiliated to the University of Calcutta for D.P.H. and D.Sc. (Public Health) and D.M.C.W. and to the Faculty of Tropical Medicine and Hygiene, Bengal for D.P.H and Hygiene. Besides there is provision for special courses intended for public health workers who may desire to have special training, in any particular branch of public health, such as malariology, T.B. etc.

The following statement indicates the provision that exists for various courses of instruction at this institute and the latest outturn of students in each course :—

	No. of seats available.	No. of students on rolls 1946-47	No. of studens passed in 1946-47
D. P. H. & D. P. H. & Hygiene	60	52	35
Certificate in Nutrition	10	6	6
Certificate in Industrial Hygiene	10	11	11
Certificate in Laboratory Techniques	30	19	12
Certificate in Biometric Techniques	10	2	2

The institute proposes to provide training facilities in sanitary engineering, biochemistry,nutrition and physiology, hygiene, microbiology, epidemiology and statistics, It is to be noted here that although the institute is also meant for research, the present provision for research scholars is inadequate.

Post-graduate courses in tropical medicine and allied branches are provided in the School of Tropical Medicine, Calcutta and provision exists for the training of 71 students. The Universities of Bombay and Madras also provide training facilities in hygiene and public health.

The activities of the Central Research Institute, Kasauli relate chiefly to the production of vaccines and sera. This includes the manufacture of vaccines, antivenom serum, serum standardisation and virus disease.

The Pasteur Institute, Coonoor, carries on research on antirabic vaccines and related problems. The laboratories also provide facilities for general bacteriological and clinical research.

The King Institute of Preventive Medicine, Guindy, provides facilities for training and research in public health work, manufacture of vaccines, sera & lymph, as well as in the analysis of water, foods and drugs.

At the Malaria Institute of India, basic research is carried on the transfusion, prevalence and prevention of malaria, systematic study of mosquitoes, types of malarial prasites, epidemiological studies and clinical work on malaria. The Institute tenders advice and assistance in the matter of antimalarial measures. It also conducts advanced courses in malariology, during the months of March-April, the period of training being 6 weeks. Ordinarily these training facilities are extdened only to the officers of Public Health Department, Army, Railways and Local Bodies ; and provision exists for training of 24 officers at a time.

Training upto graduate standard.

52. The training of medical personnel upto degree standard is perhaps the most important aspect of medical education. Statement I analyses zone-wise the facilities available in the medical colleges in the country for graduate standard of education and training in medicine and surgery leading to the M.B,, B.S. degree of Indian Universities or its equivalent. There are at present 24 medical colleges in the country more or less evenly distributed over the four zones as follows ; 7 colleges in the Northern Zone-5 in the Eastern, 7 in the Southern and 5 in the Western Zone. Of these, 15 are well-established institutions and the rest were started recently - since 1946 or thereafter. The latter have not yet completed the training of the first batch but will do so by about 1951-52. Of those recently started, five are really the five reorganised medical schools where degree courses have taken the place of diploma or licentiate courses. The present intake into each of these converted institutions is 50 students.

53. Double shift system has been introduced as an experimental measure in two institutions Medical College, Madras and Medical College, Calcutta.

.54 Excluding the new institutions which have been started recently, the 15 established colleges have been turning out in recent years a total of 860 garduates on an average every year against an intake of 1150 students. The latest intake into all the institutions - both old and new is about 1700 students.

55. With a view to augmenting the number of qualified medical personnel in the country and as a part of the resettlement scheme, the Government of India have sanctioned of a five year scheme for producing about 975 medical graduates within the next 5 years by giving advanced training to ex-service men who were licentiates or diploma holders from medical schools. The scheme has been put into operation in June 1947 in the Lake Medical College, Calcutta, with an intake of 150 students every 6 months, the period of training being 12 to 24 months. The institution has been affiliated to the University of Calcutta and its management entrusted to the Government of West Bengal.

Medical Schools.

56. There were 18 medical schools in the Indian Union which accounted for an annual outturn of about 700 licentiates. But on the accepted principle of raising the standard of medical education in the country, 5 of the medical schools have already been converted as stated in para 117 above into medical colleges for training upto graduate standard. It is also contemplated to convert soon 5 more medical schools into collegiate institutions. It is expected that all the medical schools in the country will before long be reorganised into madical colleges.

Dental training.

57. Both for under-graduate and post-graduate training in Dentistry, the available facilities in the country are very poor. There is yet no dental college in the country offering training upto degree standard in dentistry. At present dental training is imparted in the following three dental colleges Calcutta Dental College, Calcutta, Nair Dental College, Bombay and Sir Currimbhoy Ibrahim Dental College, Bombay. The number of students who qualify as dentists from these institutions is not over 50 per year.

NURSING.

58. The total number of qualified and practising nurses in India is estimated to be about 7000 in the proportion of one for every 43000 of the population, which obviously is very low when compa red to similar ratios obtaining in other countries. In views of the absence of facilities for advanced training in the provinces in nursing, the Government of India started in 1946 a Nursing College in Delhi for the following courses of instructions:—

(*a*) A 4 year course leading to B.Sc. Hons. of the Delhi University in Nursing.
(*b*) A Nursing Administrative Course of 8 month's duration, and
(*c*) A Sister Tutor's Course covering a period of about 9 months.

The last two courses are for qualified nurses and the candidates are awarded certificates by the Government of India on the successful completion of the training. The B.Sc. Hons. Course in Nursing lays particular emphasis on preventive health wo rk and the candidates who qualify will be designated as public Health Nurses. The Nursing College has a provision for an annual admission of 15 students. At present there are 17 students in the first year and seven in the second classes. It is expected that by 1952, 120 qualified nurses with B.Sc. Hons. degree will be turned out by the Institution.

REMARKS ON THE EXISTING FACILITIES.

59. Generally speaking the existing facilities in all the institutions in respect of staff, equipment accommodation and number of hospitals are just adequate for the present intake. But shortages in one respect or another are in recent years being felt particularly in such of the institutions as have increased their intake of students. The following statement gives an analysis of the position in respect of facilities available in the country for medical education and training. The latest rate of outturn of personnel shown in column 2 relates to the established institutions which have fully developed. The forecast of the total number of personnel likely to be turned out during the next 5 years shown in column 3 is based on the latest intake into all the institutions as well as on the provision that exists in the special institutions and includes the personnel likely to be produced by the new institutions.

STATEMENT XVI.

Statement showing the position in respect of facilities available for Medical Education and training.

Category of Personnel	Latest rate of outturn per year.	Total No. of personnel likely to be produced during the next 5 years (upto 1952) under the existing circumstances.
Licentiates in Medicine and Surgery	500	2500 (on the assumption that none of the existing schools ceases to function during that period).
Graduates in Medicine and Surgery	860	5940
GRADUATES IN NURSING	..	250
Diploma holders in Dentistry Post-Graduates and Personnel with ispecial training in	50	250
Medicine and allied subjects	11	Cannot be assessed to any degree of accuracy but on the basis of the latest outturn it is likely that 55 M.D. and 45 M.S. will be turned out during the next 5 years.
Surgery and allied subjects	9	
Radiology	..	20
Ophthalmology	3	45 These are only and approximate forecast as the position is very nebulous.
Pathology	..	20
Pharmacy	10	80
Sanitary Sciences	..	5
Gynaecology & Obstetrics	7	40
Oto-Laryngology	6	40
Tuberculosis	24	Cannot be assessed.
Anatomy	..	Cannot be assessed.
Physiology	..	Cannot be assessed.
Bacteriology	..	Cannot be assessed.
Biochemistry	..	Cannot be assessed.
Pathology	..	Cannot be assessed.
Malariology	24	120 on the basis that the existing facilities are fully made use of.
Publc Health & Hygiene ..	35	250
Clinical Laboratory Sciences	15	165
Nutrition	6	50
Industrial Hygiene	11	50
Biometrics	2	50

Development and Expansion.

60. A co-ordinated and comprehensive picture of the development of facilities for medical education and research may be presented from a consideration of :—

(*a*) Development and expansion projects contemplated by institutions already in existence or in the course of establishment in the country.

(*b*) Development plans which are likely to materialise as a result of on the recommendations of the Health Survey and Development Committee set up by the Government of India in 1946.

61. As regards (*a*) above, all the Medical Institution s in the country have plans for development for the next 5 or 10 year periods. The details of these plans are indicated in brief in the following statement institution-wise. This statement brings forth the salient features of the objectives of the development plans, consequential increase in the training facilities and the financial implications.

62. It is found from the above analysis of the development plans that the established institutions in the country have all contemplated increase in the intake of students into the degree courses. At the same time 5 medical schools—now at present providing facilities for training upto the diploma or licentiate standard—will be converted into graduate colleges. It is also contemplated to establish 5 new medical colleges in C.P., Bihar, Coimbatore and Baroda. Commensurate with increase in the intake of students into the colleges, the development plans envisages expansions of teaching and hospital facilities, wherever necessary. Some of the established institutions also contemplate creation of facilities for post-graduate research & training in medical and allied subjects, for instance, the development of a Hygiene Research Laboratory for post-graduate teaching and research at the Madras Medical College is proposed. The Carmichael Medical College, Calcutta, intends introducing a two year post-graduate course in Ophthalmology. This aspect of the development plans is indeed important in view of the fact that facilities for post-graduate work in medical and allied fields are sadly lacking in the country at present and wide gaps have to be filled. The following statement indicates the increase in the outturn of personnel consequent on the implementation of the various development projects. This increased rate of outturn will be from 1952 onwards and depend upon the speed with which the projects are carried out. It is, however, to be mentioned here that some of the development projects for increasing the intake of students are expected to be put into effect from 1948 onwards. The increased outturn indicated in the statement may, however, be taken to result that from 1952 onwards. The details of the facilities for research and post-graduate studies that would result on the implementation of the development projects, are, however, not available at this stage—

Proposed increase in the intake . . .	1280 students/year for graduate courses.
Consequential increase in outturn . .	960 students /year for graduate courses.
Rate of outturn of medical graduates from 1952 onwards.	2240/years.

63 . In para 125 we have stated that a comprehensive picture of the development of meidcal education in the country will not be complete unless the recommendations of the Health, & Survey and Development Committee (otherwise known as the Bhore Committee) are co-ordinated with the various development projects outlined in the previous paras. The Bhore Committee's proposals envisage an annual outturn of 4,000—5,000 medical graduates at the end of 10 years, *i.e.*, from 1956 onwards. That Committee considered India as an undivided country. The Indian Union, we feel, should aim to to produce annually 3,500 to 4,500 doctors. The requisite increase in outurn can be effected by increasing the admissions into the existing, converted and newly proposed colleges to 100-120 students annually, introducing the double shift system of teaching (the system entailing the employnment of a different set of teachers for the second shift) and by the establishment of nes colleges. Taking into consideration the long time required to establish new colleges and other difficulties such as, procurement of equipment, trained teachers etc. the Committee proposes that priority should be given to increasing the intake of students into existing institutions as well as to introducing the Double Shift System. In the case of newly established institutions, the Committee feels that it would be better to await the full development of the institutions before the question of increasing the intake is considered. Many of the existing colleges at present have hospitals attached to them, which are deficient in respect of accommodation, equipment and staff and any funds that are available would be spent more usefully on the equipment and expansion rather than

on the establishment of new colleges. New colleges should make a more modest beginning with an intake of about 50 students annually. Considered in the light of these recommendations, the development projects of the existing institutions as well as the new ones follow fairly closely the lines of development suggested by the Bhore Committee. All the established colleges which have development plans envisage increase in the intake of students to the extent of 100-120 and new colleges an intake of 50 students to begin with. But all these proposed developments will, when fully implemented, result in increasing the outturn of medical graduates by only 920 every year and the total outturn of personnel will only be about 2200/year as assessed in para. 16 above. That is to say, a deficit of 1260-2260 occurs, which will have to be covered both by introducing Double Shift System in all the medical institutions and by opening new institutions. There might, however, be certain limitations as regards the former in view of the fact that introduction of Double Shift System entails greater hospital and other facilities, which many of the institutions do not possess at present.

Establishment of new colleges in regions where there are none at present but where certain facilities, especially by way of a good hospital are available should, it appears, receive the due consideration. A case in point is the establishment of a medical college in Travancore where the State Hospital is shortly to be enlarged and improved.

64. As regards post-graduate training and research the Bhore Committee has put forward three sets of proposals, namely: (1) the establishments of an All India Medical Institute for under-graduate and post-graduate training in medical and certain allied subjects with due emphasis on research (in the laboratory and in the field of community health problems) by every department of that institute. (2) the development of training and research facilities in particular subjects in existing centres of teaching in the provinces with a view to making these enlarged facilities available, not only to the provinces concerned but also to other parts of India; (3) The establishment of special institutions for diseases such as leprosy, filariasis or kalazar which have a definite geographical distribution in each case; the location of such institutions will obviously be determined by the availability of suitable clinical material in abundance.

65. It is understood that the creation of an All-India Medical Institute is under the active consideration of the Government through a Special Committee appointed for the purpose. It is also understood that besides putting forward proposals regarding the Institute, the Committee has emphasised the importance of speedy development of training and research facilities available to the country as a whole and has further suggested that a special Sub-Committee should be appointed to visit medical colleges and submit a report on the proposed developments. Considered in this light, the research development projects of all the various special medical institutions in the country follow more or less, closely the general recommendations of the Bhore Committee as well as of the Special Sub-Committee appointed by the Government.

66. As regards Dental Training, none of the established institutions has any plan for the development of training facilities in this subject. The Bhore Committee, however, recommends—"that provision should be made for the training of 3 types of dental personnel (1) The Dental Surgeon, (2) the Dental Hygienist & (3) The Dental Mechanic. The responsibility for the training of the dental surgeon will have to be shared between medical and dental colleges while the training of the other 2 classes can be undertaken entirely by the dental colleges. In view of the difficulty in obtaining well-trained dental teachers during our short-term programme, the number of dental colleges that we propose should be opened in the country is limited. We recommend that dental colleges should be established at Calcutta, Bombay, Madras, Lucknow and Patna. Each dental college for post-graduate students should be associated with a medical college so that the teachers of the latter can assume responsibility for the instruction of dental students in those subjects which form part of the normal studies of the undergraudates in medicine".

67. In view of the urgent need of the country in this field and the paucity of funds steps, it is suggested, should be taken to implement the recommendations of the Bhore Committee and to open dental colleges at Madras, Lucknow and Patna and raise the Calcutta Dental College, Calcutta and

Nair Dental College, Bombay to the degree standards. The financial implications of the proposals for the development of the dental colleges at Calcutta & Bombay are as follows :—

nstitution	Recurring in Rs. lakhs	Non-recurring in Rs. lakhs
(1) Calcutta Dental College, Calcutta	1.49	1.69
(2) Nair Dental College, Bombay	1.49	1.69

STATEMENT XVII

Institution 1	Objectives of the plan 2	Consequential increase in the intake 3	Financial implications 4
1. King George's Medical College, Lucknow.	Increase in the facilities with a view to catering for 100 students every year instead of 75 as at present ; expansion of hospital facilities and provision for 1000 beds, deputing staff for the institution abroad for specialised training in deep X-Ray Therapy, Orthopaedic surgery, Anaesthetists, Metal disease, etc.	25 per year for the degree courses.	The details of the financial implications of the scheme have not been properly indicated.
2. Agra Medical College, Agra.	Increase in the hospital facilities from 400 to 1000 beds and increasing the intake from 50 to 100 students.	50 students per year.	Rs. 2 crores.
3. Glancy Medical College, Amritsar.	Short term plan envisaging construction of Pathology block and a 500 beded hospital as well as a 100 beded maternity hospital.	40 students per year according to the short-term plan.	*Short term plan.* Rs. 4½ lakhs capital.
	Long-term project envisaging shifting of this medical college to the proposed capital of the East Punjab Province and developing it further. Provision for research as well will be made.		*Long term plan.* Capital—Rs. 2·2 crores. Recurring—Rs. 1.22 lakhs. for the long term plan the authorities of the college are prepared to meet half the expenditure provided the other half is contributed by the Central Government.
4. Carmichael Medical, College, Calcutta.	Institution of a 2-year post graduate course in Ophthalmology ; increase in the training facilities at the institution to cater to a larger intake of students.	Additional intake into the degree courses—100. Details regarding the intake into Ophthalmological course not available.	Capital—Rs. 39·3 lakhs. Recurring—Nil. The institution is prepared to share 20 per cent of the commitment.
5. Orissa Medical College, Orissa.	The institution was started in 1944 and the development plan envisages full development of the institution with a regular annual intake of 50 students and extension of the hospital by 250 extra beds ; creation of facilities for research in all branches and especially food and nutrition, pharmaceutical chemistry, assaying, and preventive and curative aspects.	28 for the degree courses.	The Government of Orissa have already sanctioned Rs. 23 lakhs capital for the development plan. The research development plan for the institution requires an additional grant of Rs. 4 lakhs.
	(Training of Health Inspectors and Visitors (as per interim plan submitted by the Utkal university.		15 lakhs capital 5 lakhs recurring.

(1)	(2)	(3)	(4)
6. Ronaldshay Medical School, Burdwan.	The immediate plan of the institution is to increase the intake into the diploma courses by introducing double shift system. The long-term plan envisages conversion of the school into a college for M.B., B.S. degree and also of the diploma courses. When the plan is implemented the college will provide for an intake of 75 students every year. It is also intended to increase hospital facilities from 155 to 350 beds to meet the requirements of the degree courses.	Diploma courses=55 Degree courses=75	*Short-term plan* (Double Shift System) Capital—Rs. 1·38 lakhs. Recurring—Rs. 14,000. *Long-term plan.* Capital—Rs. 18·3 lakhs. Recurring—Rs. 5·68 lakhs.
7. Seth G. S. Medical College, Bombay.	The institution aims at an intake of 100 students which has already been carried out this year. Introduction of Double Shift with an additional intake of 100 students. The other aspects of the development plan relate to re-enforcement of the facilities existing in certain departments Physiotherapy, X-Ray and Electro-Therapy departments ; Provision of facilities for research.	Additional intake into degree courses=100.	The Government of India are considering sanctioning a grant of Rs. 1·33 lakhs recurring and Rs. 0·5 lakhs capital to the Institution for the Double Shift System.
8. Grant Medical College, Bombay.	Increase in the number of admissions to 140 from 100; introduction of double shift system with a view to taking in 100 more students ; increase in the facilities for research.	40 students by the general expansion and 100 students by the double shift system.	No details are available regarding the financial implications of the double shift system as well as of the increase in the training facilities. The research development plan requires Capital : Rs. 1 and 1½ lakhs recurring.
9. B. J. Medical College, Ahmedabad.	The institution which was started in 1946 is proposed to be fully developed and increasing intake from 50 to 100 is intended.	50 students per year.	Capital—Rs. 2·1 crores. The Bombay Government is meeting the entire expenditure.
10. B. J. Medical College, Poona.	Full development of the college is to cater for 50 students per year. Increase in the hospital facilities from 300 to 800 beds.		The Bombay Government have sanctioned a recurring grant of Rs. 1,26 lakhs for the institution.
11. Medical College, Nagpur.	The development plan envisages full development of the institution which was started in 1947 by construction of college buildings and creasion of hospital facilities to the extention of about 1000 beds.		
12. Medical College, Madras.	Development of the Hygiene Research Laboratory for post-graduate teaching and research in hygiene subjects for various categories of people—medical and non-medical, Research development in public health.	Details of the intake and outturn of students into the proposed hygiene courses are yet to be worked out.	Capital—Rs. 10 lakhs. The Madras Government is willing to give effect to the scheme if 50 per cent of the capital *i.e.* Rs. 5 lakhsis met by the Central Government.
13. Stanleey Medical College, Madras.	Increase in the bed strength of the hospital to 1000 beds to cater for at least 100 students instead for 72 ; creation of facilities for research as well as for the training of technicians ; expansion of the departments of the college and of the hospital facilities.	Increase in the intake into degree courses is 28 students.	No details have been furnished but it is understood that the Madras Government has sanctioned certain aspects of the plan, especially of the increase in the hospital facilities.

(1)	(2)	(3)	(4)
14. Andhra Medical College, Vizag.	Increase in the training facilities to cater to 100 students instead of 55 ; expansion of the hospital facilities to have 1000 beds instead of 700 as at present ; creation of facilities for post-graduate research and training.	Increase in the intake of students into the degree courses........45	No details of the financial implications of the development plan are available but it is understood that for research in tropical diseases the institution requires 15 Fellowships, each of the value of Rs. 200 and Rs. 50,000 capital for equipment.
15. Medical College, Mysore.	Increase in the training facilities to cater to 100 students instead of 50 ; creation of facilities for post-graduate training and research.	Increase in the intake of students into the degree courses is 50 students.	Capital—Rs. 10 lakhs. Recurring—Rs. 55,000.
16. Madura Medical College, Madura.	The institution was started in 1946 with an intake of 50 students. It is proposed to increase the admissions to 100 and provide the corresponding necessary facilities.	50 per year into the degree courses.	No information.
17. Campbell Medical School, Calcutta.	These four medical schools are, it is coten plated, going to be converted into medical colleges with provision for training upto graduate standard in medicine and surgery. The annual intake into each of these institutions will be 50 students.		
18. Dharbanga Medical School, Bihar.			
19. Arya Medical School, Ludhiana.			
20. Women Christian Medical School, Ludhiana.			
21. Raipur Medical College, C. P.	It is understood that the establishment of all these 5 new medical colleges is being contemplated. Each of these institutions will admit 50 students annually and give an outturn of about 180 graduates every year.		
22. Medical College, Bihar.			
23. Medical College for Women, Jubbulpore.			
24. Baroda Medical College, Baroda.			
25. Robertson Medical College, Coimbatore.			
26. Medical College, Travancore.	It is understood that the Government of Travancore is considering a proposal for the establishment of a medical college in the State. The financial implications of the proposal are Rs. 1·75 crores capital and Rs. 5 lakhs recurring and the Government of Travancore will bear half the expenditure provided the other half is contributed by the Central Government. The intke into the institution will be about 50 students to begin with.		
27. School of Tropical Medicine.	Abolition of the LTM. course and incresing the DTM course. There will be 2 sessio in a years, each session to train 100 students ; improving research facilities. No details of financia implications.		
28. Central Research Institute, Kasauli.	Integration of the main functions of the Institute (viz. Model production of vaccine, sera and biologicals, applied and basic research and the training of Expert Technical Personnel.		